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NOTES ON THE BREEDING SEASONS OF SOME ILLINOIS CARABID BEETLES

(Coleoptera)

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The investigations of Larsson (1939) and Lindroth (1949) have emphasized that in western Europe the Carabidae can be divided broadly into two groups according to their reproductive season: the "spring breeders" (Frühlingstiere) of Larsson or the "imaginal overwinterers" of Lindroth, and secondly, the "fall breeders" (Herbsttiere) or "larval overwinterers" of the two authors respectively. Further, it has been shown that the fall breeders tend to make up a higher proportion of the Carabid species occurring on the North Atlantic seaboard than those recurring in less oceanic regions of Europe. However, studies have not been made on mid-continental faunas. Studies on the breeding seasons of the carabid fauna of temperate North America, for which a trans-continental transect could be made, would be most informative.

The material used was collected on April 25 and May 16, 1953, during field excursions to Carlé Woods, Cook County, Illinois by the C2 Biology Class of Northwestern University under the direction of Professor Orlando Park.

Carlé Woods is an Oak-Sugar Maple Community which is the climatic climax in this region. My tentative identifications were carefully checked by Professor Park against material in his own reference collection; I am very grateful to him for this service. The names given are those of Leng (1920).

The beetles were brought back to the laboratory alive and dissected as soon as possible in a balanced saline solution of the following constitution:

Sodium chloride 9.0 gs. Potassium Chloride 0.2 gs.
Calcium chloride 0.2 gs. Distilled water to 1,000 ml.

which is a modification of Pringle's formula given in Roeder (1953). In females the states of the ovaries were noted, the eggs in the oviducts counted and the spermathecae removed to a slide for microscopic examination. In the males the states of the ac-

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cessory glands were noted and the testes and vasa deferentia removed to a slide for microscopic examination.

Carabid females possess a pair of polytrophic ovaries each discharging into a lateral oviduct which joins its fellow to form a medial vagina. In the polytrophic ovary the developing eggs are each surmounted by a ring of nurse cells which accompany the egg as it progresses along its ovariole. When the mature egg is discharged into a lateral oviduct the remnants of the nurse cell are left at the base of the ovariole and are visible as brown granules, the corpora lutea; they have no known endocrine activity. The intensity of the corpora lutea provides a rough guide to the number of eggs discharged from the ovariole. The spermatheca is an elongated sac lying, with its gland, mid-way along the dorsum of the vagina; its dissection is often difficult.

The males have typically a pair of testes each with a coiled vas deferens, although in some species the testis and its vas may be absent on one side. Each vas runs into the neck of an accessory gland, a sac which is filled with opaque white material when functional. Below these glands the lateral ducts join to form a medial ejaculatory duct. The sperm is discharged from the testis in packets, each packet consisting of a hyaline core to which the spermatozoa are attached by their heads. In many species this core elongates in the vas to form a ribbon, a twisted rope of these ribbons with sperm attached being transferred to the female at copulation.

CARABUS LIMBATUS Say

Females: 4/25/53. One specimen dissected. Ovaries contained developing eggs. Mature eggs present in the oviducts. Corpora lutea invisible. Spermatheca not examined. 5/16/53. One specimen dissected. Ovaries containing developing eggs. Mature eggs present in the oviducts. Corpora lutea faint. Spermatheca not examined.

Males: 4/25/53. One specimen dissected. Testes full of mature sperm packets. The vasa, which were divided into three regions, contained active spermatophores throughout their lengths.

This species is obviously a spring breeder and presumably a larval overwinterer. No information relevant to its life-history is given by Blatchley (1910).

EUFERONIA STYGICA (Say)

Females: 4/25/53. Three specimens dissected. In each the ovaries were small without developing eggs, and the corpora lutea

were intense. No satisfactory spermathecal preparations made.

5/16/53. Four specimens dissected. Each showed the same state as those dissected earlier. Two satisfactory spermathecal preparations were made; sperm ribbons were present but no sperm was seen attached to them.

Males: 5/16/53. One specimen dissected. The testes were full of spherical morulae; the vasa were empty and the accessory glands contained no opaque material.

This species presents a problem—have the females laid their eggs earlier in the current spring, or did they do so in the previous year and then over-winter although they had already reached sexual maturity? Blatchley gives no relevant information. In the first case the species will be a normal spring-breeder. In the second, it is probably an autumn-breeder overwintering mainly in the larval state but with a proportion of the mature adults over-wintering after reproduction. This would parallel what occurs in *Calathus erratus* Sahlberg in Britain (Gilbert, 1954).

POECILUS LUCUBLANDUS Say

Females: 4/25/53. Two specimens dissected. Ovaries small without developing eggs and without corpora lutea. Presumably neither specimen had reached maturity. Spermathecae not examined.

Males: 4/25/53. Three specimens dissected. In all three the testes contained mature sperm packets basally and immature morulae apically. A few ribbons were present in the vasa. Accessory glands contained a little opaque material.

It is probable that this is a late spring breeder. Blatchley states that the species overwinters in the imaginal state which supports this contention.

DYSIDIUS MUTUS (Say)

Females: 4/25/53. Three specimens dissected. Each contained mature eggs in the oviduct. Corpora lutea faint or invisible. The spermatheca of one specimen was examined and found to contain sperm ribbons. 5/16/53. Three specimens dissected. Oviducts contained mature eggs. Copora lutea faint. All three specimens had sperm ribbons in the spermatheca.

Males: 4/24/53. Nine specimens dissected. In each the vasa contained ribbons bearing active sperm and the accessory glands were full of opaque material. The testes of seven were examined; they were full of mature sperm packets except in one specimen

in which there was, in addition, a small number of immature sperm packets. 5/16/53. Six specimens dissected. In each the vasa contained sperm bearing ribbons and the accessory glands were full of opaque material. The testes were examined in five specimens; a great reduction in the number of mature sperm packets was noted, the upper part of the testis tubes being empty in all cases (cf. 4/24/53).

It is impossible to delimit the egg-laying period on the present data. As mature eggs were found in the oviducts of both samples it is reasonable to assume that egg laying was in progress on both dates. The faintness of the corpora lutea shows that the bulk of the eggs had not then been discharged, and also that this was the first egg-laying season of these animals. Blatchley states that this species hibernates as an adult; this agrees with the evidence derived from dissection which is of spring-breeders overwintering as imagines prior to reproduction. Blatchley also states that the adults are found from April until December; it is very probable that those found at the end of summer and in the fall are newly emerged and derived from eggs layed in the previous spring. (Carabids typically have one generation per year, usually dying soon after reproduction.) Not all imaginal overwinterers have this fall emergence; some overwinter as adults in the pupal cell.

Examination of the testes showed that during the three week period, April 25–May 16, there was a marked reduction in the amount of sperm present. As there was no compensating increase in the sperm content of the vasa it is to be assumed that during this period there was a considerable amount of copulation. The date of onset of copulation cannot be given but obviously lies before April 25.

DICAELUS POLITUS Dejean

One specimen dissected, a female, collected on May 16. Both ovaries contained developing eggs and mature eggs were present in the oviducts. The corpora lutea were well marked. Spermatozoa attached to sperm ribbons were found in the spermatheca.

This species obviously breeds in the spring and therefore probably overwinters as an adult. Blatchley gives no information on this point.

PLATYNUS SINUATUS (Dejean)

Females: 5/16/53. Two specimens dissected. In both, the ovaries were functional and mature eggs were present in the ovi-

ducts. The corpora lutea of one were faint but in the other were well marked. Both contained sperm ribbons in the spermatheca.

Males: 4/25/53. One specimen dissected. Testes full of mature packets. Many sperm ribbons in the vasa. Accessory glands full of opaque material.

This species is obviously a spring-breeder and therefore, probably an imaginal overwinterer.

Blatchley's dates, April 10–August 13, support this.

Xestonotus lugubris (Dejean)

One specimen dissected: this was a male collected on May 16. Only one testis was found. The testis contained only immature spherical sperm morulae. The vas was empty. No data recorded for the accessory glands.

From this specimen it is not possible to conjecture as to the breeding type of this species. Blatchley's dates for imagines, April 19–December 19, are not helpful.

Amphasia interstitialis (Say)

One specimen dissected, a male collected on May 16. Only one testis and vas were present. Testis full of mature sperm packets. Vas contained sperm ribbons. Accessory glands full of opaque material.

This species is probably a spring-breeder and imaginal overwinterer. This contention is supported by Blatchley's datum that "A half dozen just emerged as imagoes were noted on November 28."

Spongopus verticalis LeConte

Females: 5/16/53. One specimen dissected. This had mature ovaries with developing eggs and well marked corpora lutea. No eggs present in the oviducts.

Males: 5/16/53. Three specimens dissected. One testis present in each. Testes full of mature sperm packets. Vasa full of sperm ribbons. Accessory glands full of opaque material.

This species is a spring breeder and probably an imaginal overwinterer. Blatchley's dates for adults (April 19–August 20), support this, and suggest that the new imagine spend the winter in or near their pupal cells.

Discussion

Most of the carabid beetles examined from Carlé Woods were spring breeders. This was to be expected as the collections were made in the spring. In a few instances, notably in *Enferonia*

stygica, judgment has had to be suspended. As the samples which were examined were small the conclusions reached can only be tentative. Further investigation may show that the broad division of breeding types noted in the Carbidae of western Europe does not apply similarly to the carabid fauna of mid-western U.S.A. In addition the proximity of Lake Michigan to Carlé Woods (ca. 12 miles) may be a complicating factor owing to the Lake's ameliorating effect on climate. There is evidence (Lindroth, 1949) that carabid species distributed over a wide climatic range can be larval overwinterers in the more temperate regions and imaginal overwinterers in the more severe.

My sincerest thanks are due to Professor Orlando Park for his interest and ready assistance in this work.

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ERRATA

In Vol. 33, No. 1, page 46, line 7 *Arconotus* should read *Arctonotus*. In line 10, June 15 should be January 15; *A. lucidus* is a winter species.

NEARCTIC SPECIES IN THE LIRIOMYZA PUSILLA COMPLEX, No. 2, L. MUNDA AND TWO OTHER SPECIES ATTACKING CROPS IN CALIFORNIA

(Diptera: Agromyzidae)[1,2]

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In California the larvae of two *Liriomyza* species, *pictella* (Thomson) and *munda* Frick, new species, have caused damage to several agricultural crops, primarily tomatoes and melons. This damage has attracted the attention of entomologists concerned with control measures (Lange, 1949; Michelbacher, *et al*, 1949, 1951, 1952, 1953, 1955). These species have been determined as *Liriomyza subpusilla* Frost (now *propepusilla* Frost) and to further complicate matters, *propepusilla* has been confused with *L. brassicae* (Riley) a miner of crucifers and nasturtium (*Tropaeolum* sp.).

It is my purpose in this paper to describe these three species and to provide comparisons with *propepusilla* so that entomologists who are concerned can make reasonably accurate determinations of their specimens. Descriptions of useful characters and methods of making their measurements have been given in an earlier paper (Frick, 1956).

Three of the species, *propepusilla*, *brassicae*, and *pictella*, belong to the segregate having the genovertical plates (orbits) infuscated at least to the upper frontoorital seta. *L. munda* has these plates yellow. However, with teneral specimens of *brassicae* and *pictella*, the infuscation is frequently very faint and is sometimes absent. Therefore, a direct comparison of several characters of the three species is given (Table 1).

There is an overlapping of most characters between the species. The data have not been analyzed because there are several closely

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[2] This investigation was supported in part by a grant-in-aid from the National Science Foundation.

[3] I am indebted to Rene Malaise for the opportunity to study the holotype of *pictella* (Thomson); C. W. Sabrosky and R. H. Foote for lending specimens in the U. S. National Museum; P. D. Hurd for those in the University of California Insect Survey Collection; to all those listed in Tables 2 and 3 for collecting and rearing specimens; and to M. T. James for reviewing the manuscript.

related species still to be described. Since it is my plan to prepare a revision of the species related to *L. pusilla*, a thorough analysis of characters will be undertaken at that time.

In view of the great similarity between the species of this complex, it is deemed necessary to restrict the type series to a single host plant. In the realization that future study may well reveal differences, at present not recognized, to split the species further, type host plants have been chosen from agricultural crops. A locality where the type host plant is now extensively grown, and

Table 1.—Comparison of frequency of occurrence of the variations found in five major characters of three *Liriomyza* species.

CHARACTER	SPECIES *munda*[1]	*brassicae*[2]	*pictella*[3]
Head—genovertical plates: not black	100	—	—
black from vertex to: dorsal sfo[4]	—	—	21
ventral sfo	—	37	68
dorsal ifo	—	46	8
ventral ifo	—	17	3
Mesonotum—length of inner to outer postalar:			
1/4 to 1/3	6	—	3
1/3	3	—	50
1/3 to 1/2	44	8	47
1/2	24	20	—
more than 1/2	23	72	—
Anepisternum—pattern of black area:			
about 3/4 (Fig. 1, A)	—	—	—
about 2/3 (Fig. 1, B)	—	—	68
about 1/2 (Fig. 1, C)	18	—	32
triangular, attached (Fig. 1, D)	26	57	—
triangular, not attached (Fig. 1, E)	56	43	—
Katepisternum—black posterior marking:			
broad	—	51	68
narrow	12	43	32
none	88	6	—
Scutellum—lateral black triangles:			
small, basal setae at edge of black	88	97	5
large, basal setae deep into black	12	3	95

[1] Type series, 34 specimens.

[2] Laurel, Santa Cruz County, California, ex *Brassica nigra*, 20 specimens; Berkeley, Alameda County, California, ex *Tropaeolum* sp., 15 specimens.

[3] Homotype series, 38 specimens.

[4] sfo—upper frontoorbital setae; ifo—lower frontoorbitals.

from which a series of specimens in good condition was available, was chosen as the type locality. This has been done in the interests of stability of names for economic species and to provide an adequate future source of specimens.

Liriomyza munda Frick, new species

Agromyza (Liriomyza) pusilla (Meigen), Lange, 1949, Pan-Pac. Ent., 25:91.

Agromyza (Liriomyza) subpusilla Frost p. p., Lange, 1949, Pan-Pac. Ent., 25:91.

Liriomyza subpusilla (Frost): Michelbacher, *et al.*, 1953, Jour. Econ. Ent., 46:73; Michelbacher, *et al.*, 1953, Calif. Agric., 7(7):15 (fig. of mined tomato leaf).

Male:—Shining yellow and black. Head yellow, oceller triangle and back of head black, black reaching eye margin immediately dorsad of the median posterior curve of the eye and extending to vertex; both vertical setae arising from the black, inner at edge; genovertical plates yellow; antenna with arista black. Thorax with mesonotum black, black extending laterally to humeri and bases of presutural, supraalar, and outer postalar setae and posteriorly to one-half way between inner postalar and scutellum, meeting scutellum broadly centrally, leaving lateroposterior angles of mesonotum yellow; scutellum with moderately small black lateral triangles, basal scutellar setae on black, at edge; humeri with black spot small, humeral seta arising from yellow; anepisternum as in Fig. 1, E; katepisternum with black triangle, no darkened posterior marking; meropleurite (hypopleura) about two-thirds black; pteropleura with relatively narrow black stripe below wing base. Legs with coxae each with small basal black spot; femora yellow, each with a small dark spot distally; tibiae and tarsi dark brown. wings hyaline; calypter with margin and fringe black. Abdomen with tergites black dorsally except for narrow yellow posterior margins, all but first broadly yellow laterally (nearly all of abdomen visible from lateral view is yellow); terminalia black, cerci yellow.

Head:—In profile, eye three-fourths as wide as high, oval. Gena, midway between vibrissal angle and posterior margin, about one-fourth eye height; vibrissa strong, three relatively long setae on subcranial margin. Geno-vertical plates not raised above eye margins, each with two upper frontoorbital setae and two lower, about five orbital setulae. Antenna with third segment rounded, broader than long; setulae shorter than basal aristal thickness; arista about as long as eye width, tapering uniformly from base to tip, setulae minute. *Thorax*—Four dorsocentral setae; fourth longest, twice the second; third twice the first, only one-sixth shorter than fourth; fourth only half again as far from third as third from second, first as far from second as second is from third; intraalar present on both sides, equal in length to an acrostichal; about seven to nine setulae in the intraalar row, posterior to transverse suture; inner postalar about one-half the length of the outer; acrostichals sparse, in four irregular rows extending posteriorly to one-half the distance between third and fourth dorsocentrals; humerus with two or three setulae plus the humeral. *Wing*—About twice as long as wide. Costa terminating at wing tip, second segment nearly three times as long

as third; fourth and third about equal in length; m-m crossvein about three-fourths its length from r-m, angle of m-m moderate to penultimate section of M_{1+2}; ultimate section of M_{1+2} about 16 times the penultimate; ultimate section of M_{3+4} about three times the penultimate. *Size*—Wing length, 1.3 mm.

Female:—Larger, wing length 1.5 mm.; head with three orbital setulae on each side; thorax with fourth dorsocentral nearly twice as far from third as third; fourth and third about equal in length; m-m crossvein about from first; two and four humeral setulae; wing with m-m perpendicular to the penultimate section of M_{1+2}, ultimate section of M_{3+4} about 3.5 times the penultimate section in length; seventh abdominal segment conical, basally shining black, distally dull black, tomentose.

Holotype ♂: TRACY, SAN JOAQUIN COUNTY, CALIFORNIA, IX-22-1949 (L. L. Lewallen), ex leaf of tomato *(Lycopersicon esculentum)*, deposited in the California Academy of Science collection. Allotype ♀ and 13♂♂ and 19♀♀ paratypes: same data as the holotype. Paratypes have been deposited in the collections of the California Insect Survey, California Academy of Sciences, U.S. National Museum, State College of Washington, the Zoologisches Museum, Berlin, and the author.

L. munda may be distinguished from the three other species discussed in this paper by the yellow genovertical plates. A comparison with the other species of five important characters is presented in Table 1. The table also gives an indication of the individual variation to be expected.

Other specimens that have been examined and assigned to *munda* are listed in Table 2. It is probable that *Datura*, a common weed of waste places, serves as a host reservoir for *munda*, however, *pictella* is also found on *Datura* (Table 3). Potato does not appear to be a preferred host while the specimen from tobacco was taken by sweeping. Whether *munda* is restricted to plants of the family Solanaceae can only be determined by future collecting.

LIRIOMYZA PROPEPUSILLA Frost

Agromyza (Liriomyza) subpusilla Frost, 1943 (*nec* Malloch, 1914), Jour. N.Y. Ent. Soc., 51:255; Lange, 1949, Pan-Pac. Ent., 25:91.

Liriomyza propepusilla Frost, 1954 (n. n. for *subpusilla* Frost, 1943, *nec* Malloch, 1914, and *Phytomyza subpusilla* Frost, 1954), Ent. News, 65:73.

Holotype ♂: MANHATTAN, KANSAS, X-14-1933 (C. W. Sabrosky), deposited in the U.S. National Museum, without museum number. It is indeed unfortunate that Frost chose as the holotype a specimen taken by sweeping when specimens reared from known host plants were available. Considering the amount of

Table 2.—California records of *Liriomyza munda* Frick by host, locality, and collector

HOST	LOCALITY		DATE	COLLECTOR	TOTAL
	COUNTY	CITY	COLLECTED		EXAMINED
Solanaceae—Tomato	Lake	Kelseyville	X-4-53	W. H. Lange, Jr.	37
	Sierra	Downieville	IX-23-53	W. H. Lange, Jr.	11
	Sutter	Yuba City	VIII-5-51	W. H. Lange, Jr.	4
	Sacramento	Davis	X-22-48	W. W. Middlekauff	14
	San Joaquin	Tracy	IX-22-48	L. L. Lewallen	34[1]
		Stockton	IX-15-50	F. Hutchings	4
			IX-18-50	A. E. Michelbacher	41
		Linden	VIII-28-53	W. H. Lange, Jr.	18
		Thornton	VIII-20-51	W. H. Lange, Jr.	37
	Alameda	Oakland	IX-9-48	W. H. Lange, Jr.	1
		Berkeley	XI-5-48	K. E. Frick	4
	Contra Costa	Byron	X-8-53	E. R. Oatman	25
	Stanislaus	Patterson	X-14-48	C. A. Hanson	17
	Los Angeles	Chatsworth	VII-7-51	J. Wilcox	50
	San Diego	Encanto	VII-16-48	R. N. Jefferson	20
Potato	Fresno	Fresno(?)	IX-?-47	G. F. MacCleod	1
Datura meteloides	Stanislaus	Crows Landing	VIII-14-48	K. E. Frick	17
Frequenting tobacco	Sacramento	Davis	X-28-48	W. H. Lange, Jr.	1

[1] Type series.

Table 3.—California records of *Liriomyza pictella* (Thomson), by host, locality, and collector

HOST	LOCALITY		DATE	COLLECTOR	TOTAL
	COUNTY	CITY	COLLECTED		EXAMINED
Leguminosae—Alfalfa	San Joaquin	Wesley	VIII-21-48	R. F. Smith	11
	Stanislaus	Patterson	IX-3-48	K. E. Frick	19
	Sannta Clara	Meridian	VIII-4-48 and IX-18-46	W. H. Lange, Jr.	3
	Monterey	Salinas	XI-1-43	W. H. Lange, Jr.	6
	Orange	Santa Ana	VII-13-49	W. H. Lange, Jr.	3
Medicago lupulina	Santa Cruz	Laurel	VIII-22-48	K. E. Frick	9
Vicia gigantea	Santa Cruz	Laurel	VIII-22-48	K. E. Frick	9
Lima bean	Stanislaus	Patterson	IX-3-48	K. E. Frick	12
	Santa Clara	Sunnyvale	IX-9-48	K. E. Frick	2
Pole bean	Santa Clara	Mountain View	IX-9-48	K. E. Frick	1
Pink bean	Sutter	Yuba City and Robbins	VIII-?-45 and IX-?-45	W. H. Lange, Jr.	9
	Yuba	Marysville	VIII-IX-45	W. H. Lange, Jr.	9

Bean	Riverside	Indio	X-26-51	H. T. Reynolds	11
Malvaceae—Malva borealis	Santa Clara	Sunnyvale	IX-9-48	K. E. Frick	8
Cotton	Fresno	Oro Loma	VIII-31-48	K. E. Frick	5
Cucurbitaceae—Cantaloupe	Fresno	Oro Loma	VIII-31-48	K. E. Frick	38[1]
Cranshaw melon	San Joaquin	Vernalis	IX-9-50	A. E. Michelbacher	11
	Stanislaus	Patterson	IX-24-53	E. R. Oatman	25
Labiatae—Stachys californica	Santa Cruz	Aptos	VIII-24-48	K. E. Frick	1
Solanaceae—Datura meteloides	Stanislaus	Crows Landing	VIII-14-48	K. E. Frick	4
		Patterson	IX-22-48	K. E. Frick	25
Compositae—Helianthus annuus	Merced	Dos Palos	VIII-31-48	K. E. Frick	6
Aster, cultivated	Santa Cruz	Santa Cruz	X-3-48	K. E. Frick	1
Dahlia, cultivated	Santa Clara	Mountain View	X-3-48	K. E. Frick	4
Zinnia, cultivated	Merced	Dos Palos	VIII-31-48	K. E. Frick	2
	Alameda	Berkeley	X-25-48	R. E. Beer	1
	Santa Clara	Mountain View	X-3-48	K. E. Frick	1

[1] Homotype series.

individual variation among specimens of *Liriomyza* species, it is necessary to restrict the name *propepusilla* to the holotype.

Neither of the two California species whose larvae mine alfalfa, beans, melons, and tomatoes (Lange, 1949) is *propepusilla*. The type of *propepusilla* differs from the California species in having larger black areas, the anepisternum three-fourths black, the first dorsocentral seta no longer than an acrostichal seta, and the second dorsocentral less than one-half the length of the third.

LIRIOMYZA PICTELLA (Thomson), new combination

Agromyza pictella Thomson, 1868, Dipt. Freg. Eugen. Resa, (2)6(12):609.

Agromyza (Liriomyza) subpusilla Frost p. p., Lange, 1949, Pan-Pac. Ent., 25:91.

Liriomyza sp.: Michelbacher, *et al*, 1949, Jour. Econ. Ent., 42:666; Michelbacher, *et al*, 1955, Univ. Calif. Agric. Exp. Sta. Bull. 749:28 (figs. of mined leaves).

Liriomyza subpusilla (Frost p. p.): Michelbacher, *et al*, 1951, Jour. Econ. Ent., 44:390 (fig. of mined melon leaf); Michelbacher, *et al*, 1952, *ibid*, 45:470.

Male:—Shining black and yellow. Head yellow, ocellar triangle and back of head black, black of back reaching eye margin immediately dorsad of median posterior curve of eye, extending to vertex; both vertical setae arising from black, inner at edge; genovertical plates darkened to ventral lower frontoorbital, in width from eye margins to setal bases; antenna with arista black. Thorax with black of mesonotum extending laterally to humeri and bases of presutural, supraalar, and outer postalar setae, and posteriorly to scutellum, lateroposterior angles very narrowly yellow; scutellum with black triangles relatively large, basal scutellar setae on back, several setal-base widths from yellow; humerus with small black area, humeral seta arising from yellow; anepisternum as in Fig. 1, B; katepisternum with black triangle large, posterior black marking broad; meropleurite (hypopleura) about three-fourths black; pteropleurite broadly black. Legs with mid- and hind-coxae black, fore-coxa two-thirds black, femora yellow but broadly streaked with black, appearing dusky, hind pair darkest, tibiae and tarsi black. Wings, hyaline, calypter with black margin and fringe. Abdomen black with faint yellowish laterally on second to fifth tergites; tergites with very narrow yellow posterior margins; terminalia dark brown, cerci yellowish-brown.

Head—In profile, eye about three-fourths as long as high. Gena, midway between vibrissal angle and posterior margin, about one-fourth eye height; vibrissa strong, three and four relatively strong setae on subcranial margin. Genovertical plates not raised above eye margins, each with two upper fronto-orbitals and two lower, about five orbital setulae on a side. Antenna with third segment rounded, broader than long; setulae shorter than basal aristal thickness; arista about as long as eye width, tapering

[4] All mesonotal setae are mssing in the holotype, and the measurements are from a homotype male.

uniformly from base to tip, setulae minute. *Thorax*[4]—Fourth dorsocentral twice as long as second, first two-fifths as long as third and one-third the fourth; fourth is half again as far from the third as the third is from second, first and second and second and third about equidistant; intraalar present, equal to an acrostichal in length, about six setulae in the intraalar row posterior to transverse suture; inner postalar about one-third as long as outer; acrostichals in about four rows reaching posteriorly to half the distance between third and fourth dorsocentrals; humerus with two to four setulae plus the humeral. *Wing*—Twice as long as wide. Costa ending at wing tip, second costal segment about 3.5 times the length of the third, third and fourth subequal in length; crossvein m-m slightly more than its own length from r-m, perpendicular to penultimate of M_{1+2}; ultimate section of M_{1+2} about 11 times as long as penultimate; ultimate section of M_{3+4} nearly three times the penultimate. *Size*—Wing length, 1.5 mm.

Holotype ♂: CALIFORNIA (Kinb.), Museum No. 123, deposited in the Naturhistoriska Riksmuseum, Stockholm, Sweden. Homotypes: 22♂♂, 16♀♀, Oro Loma, Fresno County, California, VIII-31-1948 (K. E. Frick), ex leaf of cantaloupe *(Cucumis melo)*. Homotypes have been deposited in the collections of the California Insect Survey, California Academy of Sciences, U.S. National Museum, State College of Washington, Zoologisches Museum, Berlin, and the author.

The identity of *pictella* has long remained in doubt and the name has been put into synonymy under several species. It was through the kindness of Dr. René Malaise that I was able to study the holotype of *pictella*. As this species is probably the most common and destructive leaf miner in California, I have designated a series of specimens, reared from a single host plant, as homotypes so that authentic material may be available in the United States.

EXPLANATION OF FIGURES

Fig. 1. Anepisterna of four species of *Liriomyza:* (a) *propepusilla,* holotype ♂, about 3/4 black; (b) *pictella,* homotype ♂, about 2/3 black; (c) *pictella,* homotype ♀, about 1/2 black; (d) *brassicae,* triangular, triangle attached to vertical posterior dark strip; (e) *munda,* holotype ♂, triangular, triangle free from posterior strip.

L. pictella has a number of good characters that separate it from *munda* and *brassicae* (Table 1). Of major importance are the anepisternal markings and the size of the lateral black triangles of the scutellum. Although *pictella* has been frequently confused with *propepusilla*, *pictella* may be easily separated from *propepusilla* by the anepisternum being not more than two-thirds black, the first dorsocentral at least twice the length of an acrostichal, and the second dorsocentral being about two-thirds as long as the third.

The host plants of specimens at present considered to be *pictella* are listed in Table 3. This species is apparently native to California and has spread, at times in sufficient numbers to be destructive, to several crop plants. In agricultural districts several plants, but primarily volunteer alfalfa and sunflower, serve as source plants for the species to spread to suitable crop plants.

LIRIOMYZA BRASSICAE (Riley)

Oscinis brassicae Riley, 1884, Ann. Rpt. U.S. Dept. Agric., 1884:322.
Liriomyza brassicae (Riley), Frick, 1952, Univ Calif. Pub. Ent., 8:402.
Agromyza diminuta (Walker), Coquillett p. p., 1898, Bull. U.S. Dept. Agric., Ent., 10:78.
Liriomyza cruciferarum Hering, 1927, Zool. Jahrb., Abt. Syst., 53:461.
Phytomyza mitis Curran, 1931, Canad. Ent., 63:97. *New synonymy.*
Agromyza propepusilla Frost p. p., 1954, Ent. News, 65:73.

Holotype ♀: SAINT LOUIS, MISSOURI, VI-30-1876, Museum No. 783, deposited in the U.S. National Museum. *Holotype* ♂ of *mitis:* AWEME, MANITOBA, CANADA, VII-20-1929 (R. H. Handford), Museum No. 3407, deposited in the Canadian National Collection. Paratypes: 4♂♂, same data as type, reared from *Erysimum parviflorum*, deposited in the American Museum of Natural History and the Canadian National Collection. Curran designated as paratypes specimens reared from cabbage, *Brassica campestris*, and *Radicula palustris*. These I have not seen.

Probably all of the records of *propepusilla* reared from crucifers and nasturtium (Frost, 1943) refer to *brassicae*, as two of the *propepusilla* paratypes in the S. W. Frost collection belong to *brassicae*. These are: 1♀, Leisure, Allegan County, Michigan, VI-24-1938 (C. W. Sabrosky) on flowers of wild mustard, and 1♀, Ithaca, New York, VII-7-1916 (S. W. Frost), ex nasturtium. Many of the specimens of *brassicae* in the U.S. National Museum were labelled *diminuta* of Coquillett. Coquillett listed only one crucifer—cabbage, but specimens from turnip and nasturtium had been placed under *diminuta* since his time.

L. brassicae may be separated from the other species described in this paper by referring to Table 1. It differs from *propepusilla* in having the anepisternum with a subtriangular black spot (figs. 1, D and E), while the anepisternum of *propepusilla* is about three-fourths black (fig. 1, A).

In North America, *brassicae* is the only known miner of nasturtium and various species in the family Cruciferae. I have reared it from several species of mustard, including tumbling mustard (*Sisymbrium altissimum* L.), wild radish, chinese winter radish, cauliflower, and turnip in California and Washington, and have determined it from specimens collected in California, Texas, Iowa, Indiana, Washington, D.C., Virginia, and Florida that had been reared from nasturtium, mustard, cauliflower, cabbage, turnip, and rape. *L. brassicae* has been reported from Hawaii on white and common mustard cabbage (Frick, 1953).

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THE FLIGHT PERIODS OF MARTINAPIS LUTEICORNIS (COCKERELL)

(Hymenoptera: Apoidea)

The anthophorid bee, *Martinapis luteicornis* (Cockerell), is a widely distributed species having been recorded from southern California, Arizona, New Mexico, western Texas and the desert areas of northern Mexico. Yet, prior to 1950, it was considered a rare species throughout its distribution and there was only a single pair in the collection of the California Insect Survey of the University of California. For this reason two collections of more than two hundred specimens each are worthy of note. On April 22, 1950, at the outskirts of Indio, Riverside County, California, large numbers of *M. luteicornis* were collected on the blossoms of Palo Verde trees, *Cercidium torreyanum* (Wats.), between 6 and 8 a.m. by E. G. Linsley and J. W. MacSwain. Females were carrying pollen and numerous males were flying rapidly around the trees or occasionally visiting the flowers or attempting copulation with the females. By 8 a.m. females were uncommon on the flowers and male flight was too rapid to allow many additional captures. On October 24, 1951, the species was discovered at Hopkins Well, Riverside County, by P. D. Hurd, Jr. and P. H. Timberlake. A few specimens were collected between 4 and 6 p.m. at the flowers of White Dalea, *Dalea Emoryi* Gray. The following morning large numbers of males and females were collected on the *Dalea* flowers and a few additional males at the flowers of a composite, *Palafoxia linearis* Lag. Although most of the females carried pollen loads, it was not certain that these came from the *Dalea*. As the specimens from both collections are in fresh condition, the major difference in seasonal occurrence is of particular interest. This, in addition to the diurnal activity pattern, probably account for the "rarity" of this species in collections.—J. W. MACSWAIN, *University of California, Berkeley.*

A LIMNOCORIS FOR THE UNITED STATES

(Hemiptera: Naucoridae)

IRA LA RIVERS

University of Nevada, Reno

Family NAUCORIDAE

Subfamily Limnocorinae Stål 1876

Division *Limnocoraria* Stål 1876:142.

Subfamily *Limnocorinae* Montandon 1897:1; 1898:414.

Subfamily *Limnocorinae*, Usinger, 1941:8.

Subfamily *Limnocorinae*, La Rivers, 1950:368.

Genus LIMNOCORIS Stål 1860

Limnocoris Stål 1860:83.

Limnocoris, Montandon 1897:1–8; 1898:414–425; 1909:49–51; 1910:440–442; 1911:1268–1270.

Limnocoris, Champion, 1900:358–360.

Limnocoris, De Carlo, 1941:37–40; 1951:41–51.

Limnocoris, La Rivers, 1950:373.

Limnocoris lutzi La Rivers, new species

General appearance: a small species, measuring 7 mm. in length and 5 mm. in width across the embolia. In color, lighter yellowish anteriorly, light brown posteriorly with lightening on embolia and inner hemelytral borders. Venter slightly lighter posteriorly. Opaque, dull overall.

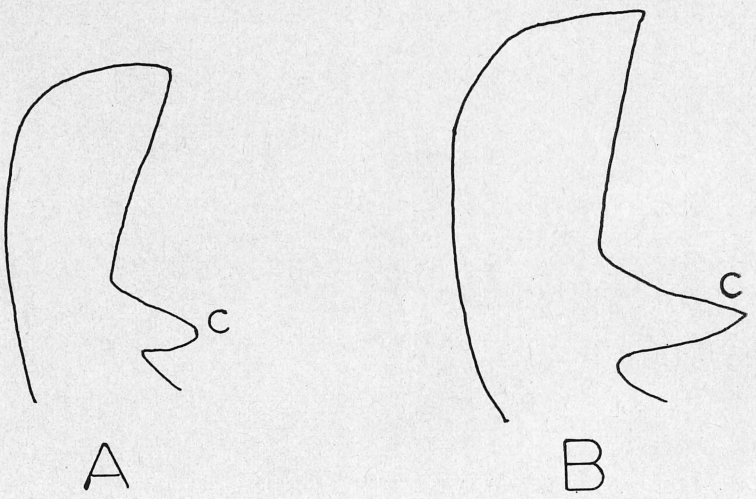
Head: Weakly, sparsely punctate, opaque; typically much wider than long, vertex protuberant before eyes to form a conspicuous but broad angle between eyes. Eyes convergent posteriorly, only very slightly elevated above the general head surface when viewed obliquely from behind; viewed from above, the outer and posterior eye-edges forming a blunt angle at their juncture. Posterior head margin weakly concave toward the caudal end. Labrum as long as wide, more-or-less parallel-sided for half its length, then coming to a point at the tip; ratio of length-to-width 30:30, uniformly light yellowish. Mouthparts darkening toward tip. Head ratios are: (1) total length to width (including eyes) 100::160 (63%); (2) anterior distance between eyes to posterior distance 108::80 (74%); (3) anterior distance between eyes to inner eye length 108::65 (60%); (4) posterior distance between eyes to greatest length of head posterior to this line 80::12 (15%).

Pronotum: Opaque, moderately, coarsely punctate, background color yellowish around edges, more reddish in center, the whole pervaded with conspicuous brownish dots, these more concentrated posteriorly; slight incipient rugosity behind head. Lateral pronotal edges smooth, curved, hind "angle" a pronounced, rather sharp curve (postero-lateral angle); percent of curvature (viewed perpendicularly to the frontal plane of section) about 21% (av. 120:25). Venter yellowish around edges, whitish toward center; keel prominent, double-tipped anteriorly—anterior tip lowest, blunt and rounded, posterior tip higher, sharp—then sloping rapidly along a sharp edge caudally and terminating in an inverted "Y" fork. The keel of

L. signoreti is grossly similar, but the terminal forks of the "Y" are shorter and narrower in the latter species. Percentagewise, the "Y" begins to fork about the midpoint of the distance from the highest, sharpest point of keel to where the keel ends posteriorly in *L. lutzi*, while in *L. signoreti* this abbreviated fork begins well caudad of the midpoint. Prosternum fused with propleura, and propleura not touching across the median line but gaping widely. Interno-posterior angles of propleura weakly but definitely pointed and protuberant in *L. lutzi*, very much elongated in *L. signoreti* into short, stubby processes. Pronotal ratios are: (1) width between anterior angles to width between posterior angles 50::93 (54%); (2) median length to greatest width 30::93 (32%); (3) distance between anterior and posterior angles on same side to perpendicular distance between anterior angle and baseline of pronotum 40::42 (95%).

Scutellum: Yellowish, darkening at tips; ratio of three sides, anterior and two laterals, 165:130:130. *Hemelytra:* Brownish in color over most of its area, with yellow prominently marking the embolia and the internal edges. Embolium long and narrow, inflated externally, the sweeping curve returning to the dominant curve of the remainder of the embolium and hemelytron at about the two-thirds point in the emboliar length; length-to-width (latter measured over greatest inflation), 56:16 (29%). Emboliar crease prominent, close to internal emboliar margin, evident only in anterior two-thirds of embolium (embolium a bit more inflated and the crease a bit more prominent in depth in *L. signoreti*). Hemelytra just about attaining abdominal tip, as in *L. signoreti*, moderately exposing connexival non-spinose edges posterior to the embolia. Species *(L. lutzi)* flightless, the non-functional hind wings greatly reduced in size, extending caudally when at rest just beyond the midpoint of abdominal segment II, in contrast to *L. signoreti*, whose hindwings reach nearly to the tip of the abdomen and have two prominent cells which latter are lacking in *L. lutzi*. *Venter:* The prothoracic venter has been discussed above. Meso- and meta-thoracic venter slightly darker in color than the pile-bearing abdomen. Connexival segments non-spinose (postero-lateral angles), although the angles are slightly more developed than in *L. signoreti*, noticeably breaking the continuity of the general connexival outline, the angles II, III and IV being the strongest, with I typically (in the sense of most naucorids) obsolescent. However, the angles are quite blunt. Connexival margins striate-impresed, the impressions lying perpendicular to the long axis of the margin, and strengthening posteriorly, becoming serrate or tooth-like along the margins in the caudal abdominal segments (the same applies to *L. signoreti*). Female subgenital plate not instructive in either *L. lutzi* or *L. signoreti*, being undistinctively rounded with a suggestion of pointing at the tip in both cases. The thoracic foveae, which give some promise of being worthwwhile taxonomic structures at least in certain species, are not significantly different between these two to be important. *L. lutzi* shows the common condition of well developed, functional meso- and meta-thoracic foveae, the former being preceded by a prominent, rather sharp tubercle much lower in elevation than the foveal suction disc. Metathoracic plate is slightly different in outline in the two species, particularly at the

outer, caudal margin where *L. lutzi* shows more curvature. Mid-ventral keel on abdominal segments I-II prominent in both species, with the thin, knife-like portion on segment I being more pronounced in *L. signoreti,* and also somewhat more reddish-translucent. Male genital process on the caudal margin of the fifth tergite, on the right of the median line, is a poorly developed but unmistakable projection occupying about the same position as in the genus *Ambrysus.* In *L. lutzi* it is short, blunt, somewhat thickened dorso-ventrally but not distinctly keeled, as in *L. signoreti*—in the latter it is also distinctly sharper at the tip. *Legs:* Forelegs with coxae yellowish, elongate, femora typically incrassate, flattened, ratio of length-to-greatest median width 46::20 (43%); in *L. signoreti* = 47::23 (49%); tibia long, slim, curved to fit against the inner edge of the femora when closed; tarsus fused nearly imperceptibly into tibia as its terminal point, and one-segmented. Midlegs with coxae trochanters prominent, undistinctive; femora long, yellow, flattened dorso-ventrally, ratio of length-to-greatest median width is 40::8 (20%), length 1.75 mm.; tibia long, narrow, more square in cross section, with prominent yellow spines along each edge, and tipped at outer end with a complete terminal spine row and a medially incomplete secondary row, as in many Ambrysi. Ratio of length-to-median ventral width is 35::5 (14%), length 1.5 mm.; tarsi long, narrow, yellow, equipped with spines below and terminating in two weakly curved, prominent claws—three-segmented, the first segment, as in Ambrysi, reduced and easily overlooked. Hindlegs are larger copies of the above described midlegs. Femoral ratio of length-to-median width 50::9 (18%), length 2.1 mm.;



Explanation of Figures

Dorsal view of right-hand lobe of the fifth tergite bearing the male genital process. A. *Limnocoris lutzi,* male allotype; B. *Limnocoris signoreti;* d. Genital process. Both drawn to the same scale.

tibial ratio of length-to-median ventral width 50::5 (10%), length 2.2 mm.; tarsus same as in midlegs but larger.

Holotype female, SEQUIN, GUADALUPE RIVER, TEXAS, 8 Sept. 50, Thos. Dolan, in the collection of Mr. John C. Lutz of Philadelphia; allotypic male in the writer's collection, Reno, Nevada.

The genus *Limnocoris* is poorly known in the northern hemisphere, and so no attempt was made in the present paper to compare the new *L. lutzi* with anything other than what appears to be the commonest, most widely distributed and hence, adjacent, species, *L. signoreti*;[1] from this latter, *L. lutzi* differs on many prominent points, and the *L. signoreti* population seemingly isolates *L. lutzi* effectively, as far as present collected material allows us to determine, from the several other species of the genus known to occupy southern Mexico and Central America. There is little need for a formalized couplet distinction between *L. lutzi* and *L. signoreti* because of the striking wing differences, among other things. The latter is also considerably larger.

Limnocoris lutzi provides the United States with two known members of the subfamily Limnocorinae—the first being the unique thermal isolate *Usingerina moapensis* La Rivers, 1950, described from southern Nevada. There is every likelihood that future collecting will add more.

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[1] Dr. Robert L. Usinger kindly loaned material of *L. signoreti* which he had compared with a cotype in the Paris Museum.

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ARRENURI FROM THE ISLAND OF YAP

(Acarina: Arrenuridae)

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Among the Acarina collections in the United States National Museum are specimens of water mites taken on the Island of Yap. These mites, collected by D. G. Frey in February 1946, are interesting in that they represent the most eastward record of Hydracarina in the Caroline Island chain. The two following species of water mites, *Neumania nodosa* (Daday) and *Arrenurus toxopeusi* Viets, have been recorded by Uchida (1935, 1939) from the Palau Islands which lie approximately 300 miles to the west.

The Yap collections contain two species of *Arrenurus*. One of these, *A. laticodulus* Piersig, is a relatively widespread species which has been found as far away as Madagascar. The other, *A. multicornutus* Walter, was formerly known only from New Caledonia. The male of *multicornutus* and the female of *laticodulus* are here described for the first time. However, it is felt that

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[1] Contribution from the Dept. of Biology, Wayne University.

allotypes have little value unless they are from the type locality and for this reason none are designated. The author wishes to thank Dr. Edward W. Baker for the opportunity to examine these mites.

ARRENURUS (MEGALURACARUS) LATICODULUS Piersig

(Figs. 1, 2, 7)

A. laticodulus Piersig, 1898. Zool. Anz. 21:571.

Male:—Length 1.39–1.48 mm.; greatest width 1.03–1.15 mm.; greatest height 1.16–1.40 mm.; width of cauda 0.79–0.92 mm. Body proper bulging anterior to eyes; with two small projections on either side of the midline, these with small round clear areas; small projections present over the eyes; with two very large, bluntly-pointed humps immediately back of eyes; sides of body proper nearly parallel, abruptly tapering in region of acetabular plates; cauda short, with pointed posterio-lateral projections; cauda without a median indentation; acetabular plates covered with numerous, short setae.

Female:—Length 1.72–2.24 mm.; greatest width 1.44–1.85 mm.; greatest height 1.53–1.75 mm. Anterior end of female similar to that of male; with two large humps back of eyes, these very steep angled in front; a pair of moderately developed, bluntly pointed humps placed posterio-laterally and a pair of similar humps at the posterior end; dorsal shield somewhat rounded, with two humps near posterior end; height of body in region of dorsal shield humps almost as high as in region of humps back of eyes; genital opening small; acetabular plates narrow, directed posterio-laterally to region of Gland E-2, and then passing laterally.

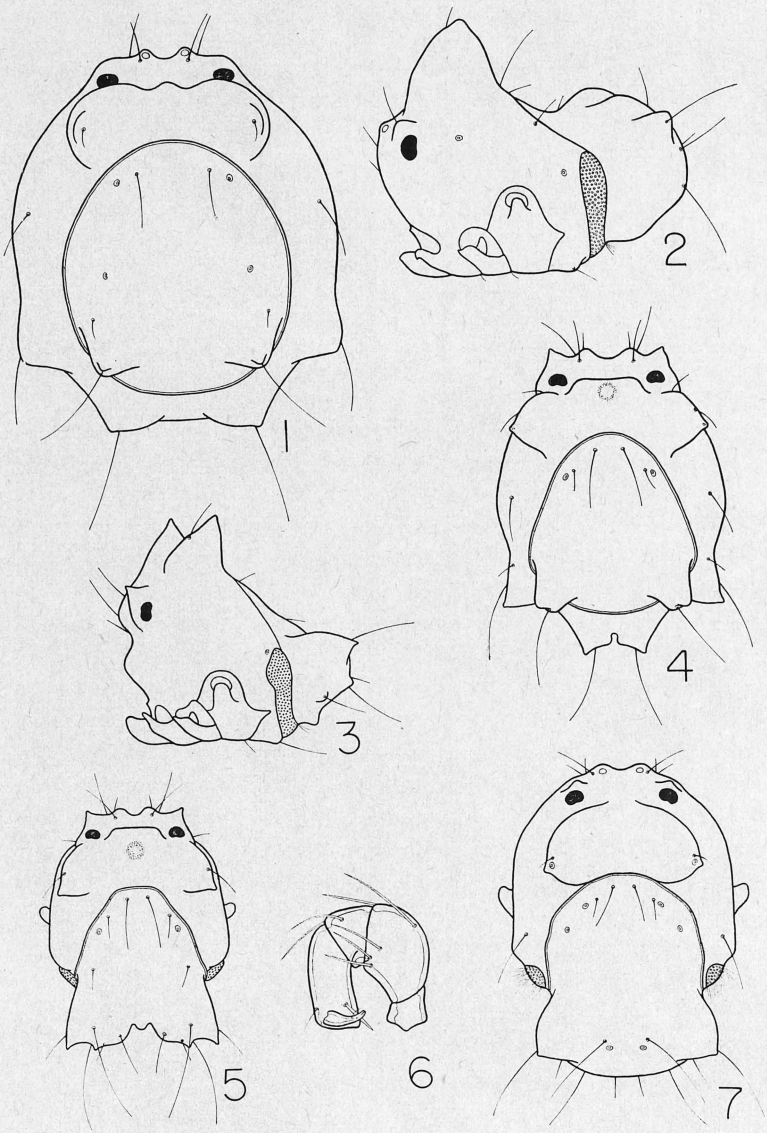
On the Island of Yap this species has been taken in two distinct habitat types. One of these was a stream near Okau, the other a water-filled shell crater (artificial pond conditions). It would seem probable that the reservoir populations are to be found in streams. As mentioned earlier, this species is widely distributed. *A. laticodulus* was originally described from the Bismarck-Archipelego, but has since been taken in Sumatra, Java, Yap and Madagascar. For a complete list of citations on this species, see Lundblad (1946).

ARRENURUS (MEGALURACARUS) MULTICORNUTUS Walter

(Figs. 3–6)

A. multicornutus Walter, 1915. Nova Caledonia 2:118.

Male:—Length, based on a single specimen, 1.26 mm.; greatest width 0.99 mm.; width of cauda 0.79 mm.; greatest height 1.24 mm. Body proper bulging anterior to eyes; two sharp-pointed projections on lateral part of this bulge and a pair of small rounded humps located medially; anterior portion of body proper with three large, pointed humps of approximately the same height; the median hump between the eyes, the lateral humps back of eyes; dorsal furrow complete, passing onto ventral side just posterior to acetabular plates; cauda wide, narrowest at base; posterio-lateral corners of cauda sharp-pointed; median indentation present at posterior end, with a



Explanation of Figures

Fig. 1, *A. laticodulus* Piersig, dorsal view, female. Fig. 2, *A. laticodulus* Piersig, lateral view, male. Fig. 3, *A. multicornutus* Walter, lateral view, male. Fig. 4, *A. multicornutus* Walter, dorsal view, female. Fig. 5, *A multicornutus* Walter, dorsal view, male. Fig. 6, *A. multicornutus* Walter, palp, female. Fig. 7, *A. laticodulus* Piersig, dorsal view, male.

small rounded projection in the middle of this indentation; a pair of small, bluntly-pointed projections between the median indentation and the posterio-lateral edge of the cauda; dorsal shield without humps; body highest near anterior end and tapering rapidly towards posterior end; a pair of small, rounded humps located on ventral side slightly posterior to acetabular plates, these best seen in lateral view.

Female:—Length 1.39–1.77 mm.; greatest width 1.04–1.37 mm.; greatest height 1.17–1.57 mm. Anterior portion of female as in male; a pair of well developed, sharp-pointed humps on the posterio-lateral portion of the body; two closely set projections at posterior end, these with a narrow notch between them; dorsal shield much narrower in front than behind; dorsal shield with two large humps near posterior end; body highest at anterior end; acetabular plates extending posterio-laterally to region of Gland E-2 and then directed laterally; distal end of second palpal segment with two to four moderately long, ventro-medially located setae.

The habitat of the present species is similar to that of *A. laticodulus*, with specimens having been taken in both the stream and shell crater. Walter (1915) described *A. multicornutus* from a single female collected at New Caledonia. While the New Caledonia specimen is much larger (length 2.1 mm.) than the individuals from Yap, it is felt that in view of the great variation (length 1.39–1.77 mm.) found in females from the present collection, we are probably dealing with extremes of variation within a single species. Walter stated that four setae were present on the inner side of the second palpal segment in the New Caledonia female. There was a variation of two to four of these setae on the second palpal segment in the individuals from Yap.

The deep median cleft in the cauda of the male gives this species a superficial resemblance to certain members of the subgenus *Micruracarus*. Since, however, the dorsal furrow in males of *multicornutus* is complete and passes onto the ventral surface posterior to the acetabular plates, the author feels that this species belongs in the subgenus *Megaluracarus*.

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NOTES ON THE BIOLOGY OF THREE ELATERIDS INJURIOUS TO VEGETABLE CROPS

(Coleoptera)

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In southern California the wireworms *Drasterius livens* (LeConte), *Cardiophorus tenebrosus* (LeConte), and *Anchastus cinereipennis* (Eschscholtz) are frequently found in lima bean fields associated with the wireworms *Limonius californicus* (Mannerheim) and *Melanotus longulus* (LeConte). All these wireworms are serious pests of vegetable and field crops. They destroy seed, cut off or tunnel the stems of growing plants, and burrow into potatoes and other root crops, rendering them unmarketable. While working out the life history of the last two species between 1930 and 1937 in southern California (Stone 1941 and 1944), the writer also studied the biology of these three lesser known species, and these data, together with notes on their activity in the field, are presented in this paper. Publication of these notes was delayed in the hope that in time more information could be obtained on the biology of these species.

DRASTERIUS LIVENS LeConte

(Figure 1)

Mixed populations of this species and of *Limonius californicus* are frequently encountered in fields planted to row crops. Data on their abundance and depth distribution in the soil were obtained by digging twenty ½-square-foot soil samples, 15 inches deep, at monthly intervals in a corn field near El Monte, California. In 100 samples sifted during the period October 31, 1932, to February 25, 1933, a total of 470 larvae of both species were recovered, 7.6 per cent of which were *Drasterius livens*. The moisture content of the soil was similar at each sifting, averaging 18, 20, 22, and 22 per cent (dry weight) at the 3-, 6-, 9-, and 12-inch depths, respectively. In the summary of these data for all months (table 1) it is noted that larvae of *livens* prefer the upper stratum of the soil, even though soil temperatures remained low, averaging 53.8° F. at the 4-inch depth during the period of this survey.

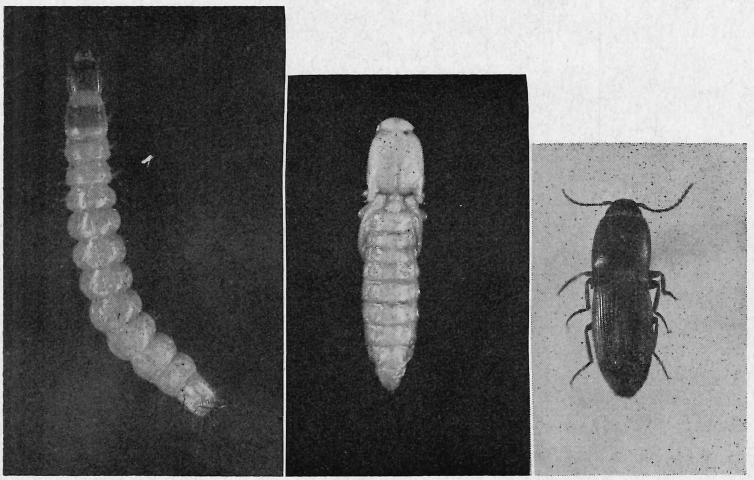
Table 1.—Relative abundance and distribution of *Drasterius livens* and *Limonius californicus* larvae at different soil depths in El Monte, California, 1932–33.

Depth of soil sample (inches)	Number of larvae recovered	
	californicus	*livens*
3	66	18
6	180	15
9	131	2
12	46	1
15	11	

The procedure followed in conducting the life history studies and in handling the various stages has been described (Stone 1935).

Incubation period—The duration of the incubation period for 115 eggs deposited between March 27 and April 28, 1932, ranged from 25 to 34 days, and averaged 28.4 days. Temperatures in the basement of the laboratory during this period averaged 67.9° F.

Larvae—The larvae used in the rearing studies begun in 1932 were from eggs deposited by field-collected adults from April 4 to 28. These eggs hatched between May 1 and 27. Of the 42 larvae being reared, 14 per cent pupated between August 16 and Septem-



A B C

EXPLANATION OF FIGURE

Fig. 1.—The wireworms *Drasterius livens*. *A*, larva, ×5; *B*, pupa, ×5; *C*, adult, ×7.5.

ber 9, and 12 per cent died. The first adults emerged on September 4 and the last on September 29. Of the 31 specimens remaining, 67 per cent pupated the following year, between June 7 and July 28, and 7 per cent succumbed. Adult transformation in this group occurred between June 29 and August 13.

Some individuals have a short larval period and mature in one season, while others have a much longer larval period and do not mature until the second year (table 2).

Table 2.—Length of developmental stages of the 1932 brood of *Drasterius livens* when reared in salve cans. Alhambra, California.

Stage	Completed development in 1932			Completed development in 1933		
	Mean temperature (°F.)	Length of stage (days) Range	Average	Mean temperature (°F.)	Length of stage (days) Range	Average
Egg	68.2	29– 34	30	68.3	25– 30	29
Larval	72.2	85–109	100	67.7	379–438	410
Prepupal	—	2– 4	3	—	2– 12	6
Pupal	73.9	17– 20	19	73.0	16– 23	20
Egg, larval, and pupal	72.6	136–158	148	68.1	429–485	459

Prepupal and pupal periods.—Larvae preparing to pupate construct an earthen cell about ½ inch long and remain in this cell until they emerge as adults. In the group completing development in one year, the first prepupa was obtained on August 16 and the last on September 9, 1932. Larvae completing development in two years entered the prepupal stage earlier, on June 1 and the last on July 29, 1933. The duration of the prepupal period varied with the temperature, averaging 3 days in 1932 and 6 days in 1933.

The duration of the pupal period was about the same when development was completed the first or the second season. The first group pupated between August 16 and September 9, and the second group between June 7 and July 28. The length of the developmental periods when reared in salve cans is shown in table 2.

Adults.—Adults of this species fly readily, being especially active on warm days. Overwintering adults were collected on alfalfa at El Monte, California, on February 21, 1934, and under malva traps (Campbell and Stone 1939) at Huntington Beach from

March 3 to April 25, 1932. A single specimen was collected at Ventura on March 1, 1934. A group of adults collected under malva traps on April 3, 1932, remained alive until May 27. Adults of the summer brood were numerous on squash at Chatsworth on August 26, 1932.

Oviposition.—In the absence of laboratory-reared or newly emerged adults, data on oviposition were obtainable from 10 females collected under malva traps near Smeltzer, California, from April 3 to 25, 1932. These adults deposited from 15 to 51 eggs, or an average of 32 eggs, each from April 7 to May 2. However, some egg deposition may have occurred prior to the capture of these adults.

CARDIOPHORUS TENEBROSUS (LeConte)

(Figure 2)

The larvae are whitish and may be distinguished from other elaterid larvae in that every other segment is enlarged. They are limber, and when picked up at the middle both ends hang down, stringlike. Newly hatched larvae average 2.5 to 3 mm. in length, and mature larvae reach a length of 25 mm. Owing to their fragile condition at the time of hatching, none were ever reared to maturity in the laboratory.

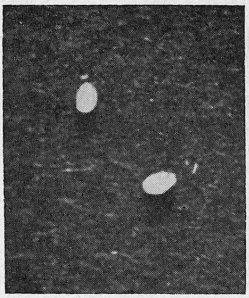
C. tenebrosus larvae may be found associated with *californicus* in sandy soils as well as in the soils of heavier texture found in lima bean fields. They rank next to *Drasterius livens* in abundance and in the damage inflicted on the bean crop. In studies to determine the effect of winter cover crops on wireworm populations in Ventura County, 2.4, 2.8, and 8.4 per cent of the 535 larvae recovered in soil samples taken in three bean fields in 1940 were *tenebrosus* and the remainder *californicus*.

The adult females are slightly larger than the males, averaging 2 mm. in width and 8 mm. in length. They are shining black and capable of flying considerable distances. In 1931 they were collected on alfalfa at El Monte on February 17 and at weekly intervals thereafter until April 16. The earliest collection at El Monte in 1934 was on February 9, and they were most numerous from March 1 to 7. They were taken on alfalfa at Smeltzer on February 1, 1935, and at Cypress on January 26, 1936. Adults were collected at Arcadia on February 10, 1937, and at Alhambra on February 13, 1938. A few specimens were collected at Ventura on February 5, 1941.

When confined in salve cans in moist soil from the time of mating, adult males remained alive for about 22 days, and females for 30 days. Death of the last male and female under observation occurred on April 7 and 17, 1932.

The numbers of eggs deposited by a group of 9 females taken in copulation between March 8 and 24, 1932, ranged from 82 to 198 and averaged 134. The length of the pre-oviposition period for this group averaged 10 days. Oviposition began on March 17, reached a peak during the week ending April 2, and terminated on April 17. The length of the oviposition period averaged 15 days.

The duration of the incubation period for 590 eggs laid from March 14 to April 17, 1932, which hatched over a period of 37 days between April 16 and May 22, ranged from 30 to 39 days, and averaged 33. Temperatures in the laboratory basement during their period of incubation average 67.8° F.



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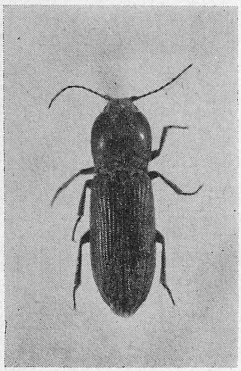

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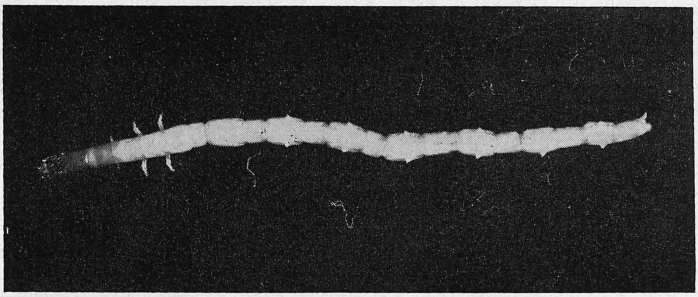


B

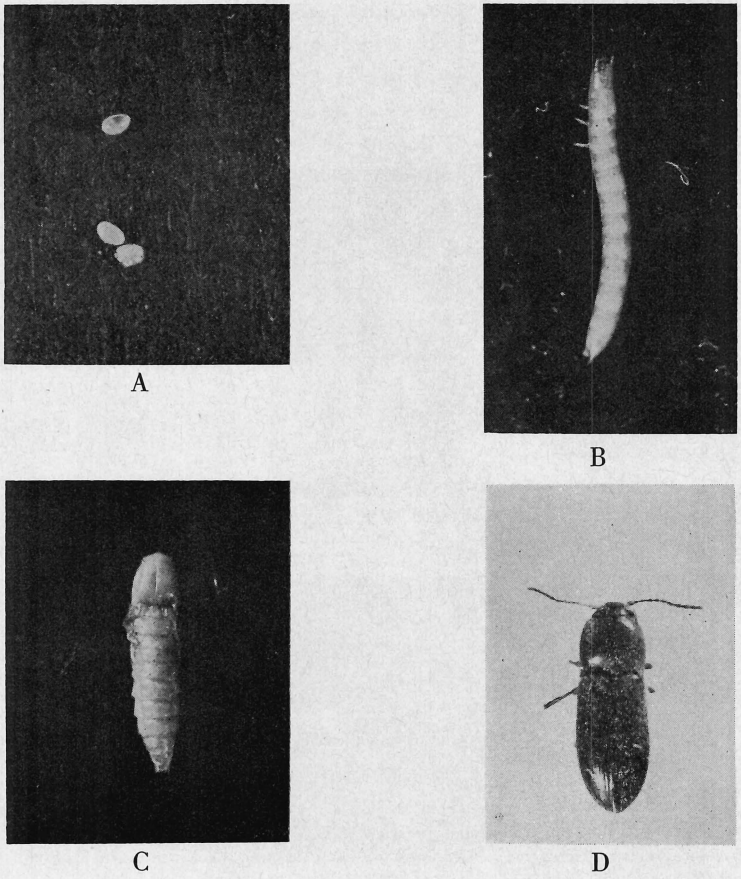
EXPLANATION OF FIGURE

Fig. 2.—The wireworm *Carliophorus tenebrosus*. *A*, egg, ×10; *B*, larva, ×4.6; *C*, *pupa*, ×4.5; *D*, adult, ×5.

The eggs are pearl white, becoming darker as the embryo develops. Measurements of 10 eggs showed an average width of 0.4 mm. and length of 0.64 mm.

ANCHASTUS CINEREIPENNIS (Eschscholtz)
(Figure 3)

This is the least common of the elaterids found in southern California lima bean fields. The larvae are small, being only 9 mm. long when mature. Adults are light to dark brown, and average 1 mm. wide by 4 mm. long. They were collected under malva



EXPLANATION OF FIGURE

Fig. 3.—The wireworm *Anchastus cinereipennis*. *A*, egg × 11; *B*, larva, ×5; *C*, pupa, ×6; *D*, adult, ×7.5.

traps near Huntington Beach, California, in early March of 1932, 1935, 1936, and in 1937.

In the absence of reared adults, data on egg deposition were obtained from females collected in malva traps on April 4, 1934. The number of eggs deposited by four individuals ranged from 45 to 123 and averaged 76 eggs. All females were dead by May 4.

The eggs are pearly white and translucent when first laid. They are ovate, and many have one end flattened. Ten eggs averaged 0.44 mm. in length and 0.31 mm. in diameter.

The newly hatched larvae are very delicate and difficult to rear. Of 38 larvae that hatched between April 20 and May 3, 1934, 37 died in 1934, and the remaining specimen pupated on September 25, 1935. The egg stage in this group averaged 27 days and the larval period 516 days. In another group of 19 larvae, which hatched in May 1936, nine pupated between September 4 and 17, 1937, and transformed to adults in October 1937. These studies indicate that this species requires two years to complete development when reared under laboratory conditions.

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ZOOLOGICAL NOMENCLATURE: NOTICE OF PROPOSED USE OF THE PLENARY POWERS IN CERTAIN CASES FOR THE AVOIDANCE OF CONFUSION AND THE VALIDATION OF CURRENT NOMENCLATORIAL PRACTICE (A. (N.S.) 35)

Notice is hereby given that the possible use by the International Commission on Zoological Nomenclature of its Plenary Powers is involved in applications relating to the under-mentioned names included in Double-Part 2/3 and Part 4 of Volume 13 of the

Bulletin of Zoological Nomenclature which will be published on 29th March, 1957.

(a) *Applications in Double-Part 2/3 of Volume 13*

(4) *Dictyoploca* Jordan, 1911, validation of (Class Insecta, Order Lepidoptera) (Z.N.(S)1072);

(5) *Staphylinus* Linnaeus, 1758, designation of *Staphylinus erythropterus* (emend. of *erytropterus*) Linnaeus, 1758, as type species of (Class Insecta, Order Coleoptera) (Z.N.(S.)242);

(6) *Anopheles* Meigen, 1818, designation of a type species for, in harmony with accustomed usage (Class Insecta, Order Diptera) (Z.N.(S.)1165);

(9) *Toxorhynchites* Theobald, July 1901, validation of (Class Insecta, Order Diptera) (Z.N.(S.)1166);

2. The present Notice is given in pursuance of the decisions taken on the recommendation of the International Commission on Zoological Nomenclature, by the Thirteenth International Congress of Zoology, Paris, July 1948 (see *Bull. Zool. Nomencl.* 4:51–56, ibid. 5:5–13, 131).

3. Any specialist who may desire to comment on any of the foregoing applications is invited to do so in writing to the Secretary to the International Commission (Address: 28 Park Village East, Regent's Park, London, N.W.1., England) as soon as possible. Every such comment should be clearly marked with the Commissioner's File Number as given in the present Notice, and sent *in duplicate.*—FRANCIS HEMMING, *Secretary to the International Commission on Zoological Nomenclature.*

NOTES ON THE OCCURRENCE OF SINODENDRON RUGOSUM MANNERHEIM IN IDAHO

Sinondendron rugosum Mannerheim is a well-known stag beetle, commonly occurring in California and the western parts of Oregon, Washington and British Columbia where it is found in the dead wood of willow, alder and poplar. During the past several years this species has been taken in moderate numbers at two widely separated localities in Idaho. In the northern part of the state, at Spalding, Nez Perce County, it occurs most abundantly, having been collected from rotting and solid wood of cottonwood *(Populus hastata)* logs in contact with the ground. In southern Idaho, in Rock Creek Canyon, approximately 13 miles south of Rock Creek, Twin Falls County, specimens have been taken from rotting logs of water birch *(Betula occidentalis)*. So far as is known this is the first recorded occurrence of this lucanid in Idaho.—W. F. BARR, *University of Idaho, Moscow.*

A NEW GENUS AND SPECIES OF TETRANYCHIDAE[1]
(Acarina)

ROBERT E. BEER AND D. S. LANG
University of Kansas, Lawrence

Schizonobiella Beer and Lang, new genus

True claws reduced to short slender pads bearing one pair of tenent hairs. Empodium short, stout and strongly uncinate, bearing on each side a single row of hairs anastomosing near their apices to form a terminal tenent. Female tarsus I and II each with a single pair of duplex setae. Male tarsus I with three or four pairs of duplex setae; tibia I with six to eight pairs of duplex setae; tarsus II with a single pair of duplex setae.

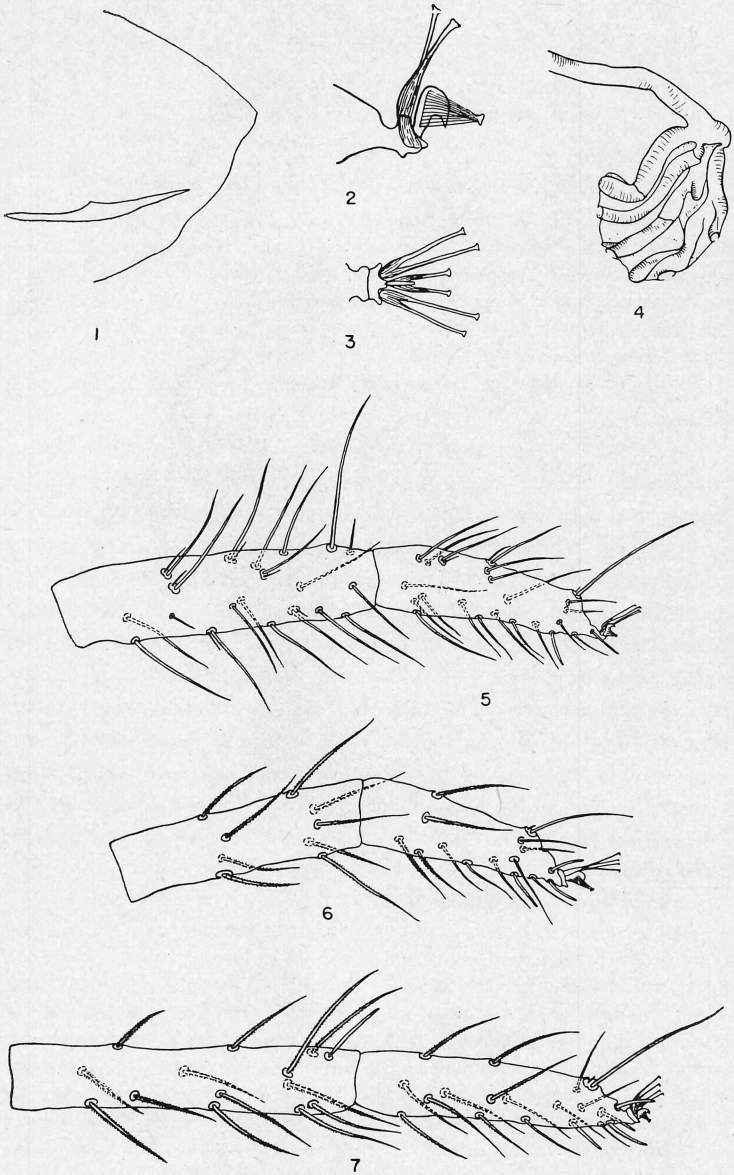
Type of genus: Schizonobiella aeola, Beer and Lang, new species.

This genus is proposed to accommodate a species that shows considerable affinity with *Schizonobia* Womersley and *Petrobia* Murray, but significant differences are apparent. Like *Schizonobia* the empodial tenent hairs have united but the degree of unity is less pronounced in *Schizonobiella.* In *Petrobia* the empodial tenent hairs are free. Unlike any known genus in the family Tetranychidae, the female of *Schizonobiella* has a single pair of duplex setae on tarsus I and the male has three pairs of duplex setae on this segment. The male is also unique in having duplex setae on tibia I. The peritremes of *Schizonobiella* apparently are more similar to those of *Schizonobia* and *Hystrichonychus* than to *Petrobia,* although the exact nature of these structures in *Schizonobia* is rather vague in Womersley's (1940) description of the genus.

Schizonobiella aeola Beer and Lang, new species

Female:—Terminal sensillum of palpus long, slender, peglike, rounded on distal end. Stylophore one and one-half times as long as broad, emarginate on posterior margin, broadly rounded on anterior margin, striations longitudinal, irregularly so; peritreme elbowed, terminating in complex, anastomosing enlargement. Tarsus I with one pair of duplex setae, proximal member minute; ten tactile and one sensory setae proximal to duplex setae. Tibia I with thirteen tactile and one sensory setae. Tarsus II with one pair of duplex setae, proximal member minute; seven tactile and one sensory setae proximal to duplex setae. Tibia II with nine tactile setae. Striations of all legs transverse. Dorsal setae longer than longitudinal interval separating adjacent setae, plumose, tapering to a point; three pairs of dorsal propodosomal setae; one pair of humeral setae; three pairs of dorsocentral and three pairs of dorsolateral setae; two pairs of sacral setae; one pair of clunal setae; all dorsal setae set on tubercles. Three pairs of genital setae

[1] Contribution number 955 of the Department of Entomology, University of Kansas.



Explanation of Figures

Schizonobiella aeola Beer and Lang, new species. Fig. 1, Aedeagus of male. Fig. 2, Pretarsus of female leg II (lateral aspect). Fig. 3, Pretarsus of female leg II (dorsal aspect). Fig. 4, Peritreme of female. Fig. 5, Tibia and tarsus I of male. Fig. 6, Tibia and tarsus II of female. Fig 7, Tibia and tarsus I of female. All figures drawn from holotype and allotype specimens.

present. Dorsal striations irregular, mostly transverse. Length of body 630μ, including rostrum 700μ; greatest width 680μ.

Male:—Similar to female. Tarsus I with three pairs of duplex setae, the first pair with proximal member minute, second and third pairs with promixmal member about one-third as long as distal member; five tactile setae proximal to last pair of duplex setae. Tibia I with six to eight pairs of duplex setae, ten to thirteen tactile and two sensory setae. Tarsus II with one pair of duplex setae, proximal member minute; nine tactile setae proximal to duplex setae. Tibia II with nine tactile setae. Aedeagus long, linear, gradually tapering to an acuminate tip, bending slightly dorsad. Length of body 500μ, including rostrum 560μ.

Holotype female, SIX MILES SOUTH OF ALICE, TEXAS, July 18, 1954, W. T. Atyeo, sweeping grass. *Allotype:* Male, same data as holotype. *Paratypes:* Two males and thirteen females, same data as holotype.

Holotype, allotype, one male and eleven females (paratypes) in the Snow Entomological Museum, University of Kansas. One male and two females (paratypes) deposited in the United States National Museum.

Considerable variation in size, number and distribution of setae on the male tibia and tarsus I is apparent in this species. One of the three male specimens in the type series has four rather than three pairs of duplex setae on tarsus I. The length of the proximal members of duplex setae on tarsus I, except for the seta of the first pair which is always minute, may be very short or one-third as long as the distal member. Because of this variability in male leg chaetotaxy, a female specimen has been selected as holotype for this species.

Due to the rather loose association of empodial tenent hairs, these sometimes become separated into groups which present the appearance of an abnormal condition that is due entirely to the mounting technique used. The most frequent abnormality of this type would appear as two groups of hairs, each with a terminal tenent, on each side of the empodial claw. Such anomalous configurations of the pretarsi, however, are easily interpreted by studying the pretarsi of all eight legs on the specimen, since mites mounted with reasonable care rarely appear with this deformity on more than one or two appendages.

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ZOOLOGICAL NOMENCLATURE: NOTICE OF PROPOSED USE OF THE PLENARY POWERS IN CERTAIN CASES FOR THE AVOIDANCE OF CONFUSION AND THE VALIDATION OF CURRENT NOMENCLATORIAL PRACTICE (A. (N.S.) 35)

Notice is hereby given that the possible use by the International Commission on Zoological Nomenclature of its Plenary Powers is involved in an application relating to the under-mentioned names included in Part 5 of Volume 13 of the *Bulletin of Zoological Nomenclature* which will be published on 6th May, 1957.

(1) *squilla* Linnaeus, 1758 *(Cancer)*, suppression of; *adspersus* Rathke, 1837 *(Palaemon)*, designation of; as type species of *Palaemon* Weber, 1795 (Class Crustacea, Order Decapoda) (Z.N.(S.)446);
(2) *Dracunculus* Reichard, 1759, validation of, with *Gordius medinensis* Linnaeus, 1758, as type species (Class Nematoda) (Z.N.(S.)553);
(3) *Mansonia* Blanchard, 1901, validation of (Class Insecta, Order Diptera) (Z.N.(S.)1193);

2. The present Notice is given in pursuance of the decisions taken on the recommendation of the International Commission on Zoological Nomenclature, by the Thirteenth International Congress of Zoology, Paris, July 1948 (see *Bull. Zool. Nomencl.* 4:51–56, 57–59; ibid. 5:5–13, 131).

3. Any specialist who may desire to comment on any of the foregoing applications is invited to do so in writing to the Secretary of the International Commission (Address: 28 Park Village East, Regent's Park, London, N.W.1., England) as soon as possible. Every such comment should be clearly marked with the Commissioner's File Number as given in the present Notice, and sent *in duplicate.*

4. If received in sufficient time before the commencement by the International Commission of voting on the application in question, comments received in response to the present Notice will be published in the *Bulletin of Zoological Nomenclature:* comments received too late to be so published will be brought to the attention of the International Commission at the time of the commencement of voting on the application in question.

FRANCIS HEMMING, *Secretary to the International Commission on Zoological Nomenclature.*

FLUORESCENT DIFFERENTIATION OF THE INTERNAL ORGANS AND TISSUES OF INSECTS[1]

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While studying the effects of shortwave ultraviolet radiation on living termites, it was learned that a strong fluorescence of these insects became apparent whenever they were exposed to certain wave-lengths in the near-ultraviolet portion of the spectrum. In an effort to better observe this interesting phenomenon, three species of termites, along with various other insects and other arthropods, were included.

The source of ultraviolet light found best suited for this study was a commercial mercury vapor lamp of high intensity and pressure emitting most of its light energy in the region of 3650 Angstrom units. This lamp concentrated its illumination into a parabolic beam and was well-suited for low-power microscopy as well as for examination with unaided eye. The shorter wave-lengths in the region of 2537A were also tried but fluorescence in this range was slight.

Of the three species of termites used for experimentation, the subterranean termite, *Reticulitermes hesperus*, responded with the highest degree of fluorescence. Excitation to a slightly lesser degree was found in the drywood termite, *Kalotermes minor*, while the dampwood termite, *Zootermopsis angusticollis*, fluoresced the least of the three. All, however, fluoresced brightly whenever they were placed under the lamp.

Microscopic examination of the termites clearly indicated that only the soft portions of the body fluoresced. The heavier chitin of the head, particularly the head and mandibles of soldiers, was negative. Also the heavier and darker armor of the alates and reproductives gave negative response, with the exception of the connective membranes. Here a strong fluorescence was noticed and became more apparent when the conjunctiva were stretched to expose more of the soft, transparent, chitinous area of these membranes. The dark brown alates of the subterranean termites, with wings attached, reacted negatively when a beam of ultra-violet light was directed down upon them. Those, however, that had broken off their wings showed narrow lines of fluorescence

[1] Submitted for publication on December 11, 1955.

in the areas of connective membranes and, when turned over, emitted a slight fluorescence in the areas where the softer ventral chitin was exposed. It was here that the conjunctiva became strongly excited with a bright blue-white glow and indicated that fluorescence came from beneath the chitin.

In order to determine if the internal content of termites fluoresced, a series of dissections was made. A small embroylogical dish was converted into a dissecting tray. The bottom was filled with melted beeswax to form a soft floor; beeswax was used because of its non-fluorescence factor. A termite was selected, anesthetized, and placed ventral side up. By melting the wax beneath the specimen with a hot point, the body became firmly embedded and ready for dissection. An incision was made just through the chitin wall starting at the vent and progressing anteriorly to the head. The flaps were carefully opened and melted into place in the wax to either side, leaving the body content completely exposed. At the first incision, the adipose tissue emitted a strong bluish-white color, which became noticeable as more of it was laid open. Small bits of chitin were cut away and examined for fluorescence and in all cases found to be negative. It was the adipose tissue, not the chitin, that fluoresced. The following is a brief description of the fluorescence of the body contents of the three species of termites dissected under ultraviolet light using a power of nine diameters of the wide-field miscroscope.

Internal Anatomy

Zootermopsis angusticollis, large worker. The surrounding adipose bodies fluoresced a bright blue-white. In sharp contrast the content of the Malpighian tubules fluoresced a strong yellow; and the tubules could be traced to their origin within the haemolymph and back to their entry into the postventricular region and point of attachment at the pyloric valve. The "ring" of the pyloric valve emitted a fluorenscence of bright blue which became invisible under white light at the same magnification.

Z. angusticollis, reproductive female. Similar to worker with exception of the reproductive system. Here the mature eggs fluoresced a pale yellow and could be followed down to an early developmental stage, when fluorescence became progressively less apparent.

Reticulitermes hesperus, reproductive male. Surrounding adipose tissue fluoresced a brilliant shade of light blue-white, while the thoracic muscles gave off a pale yellow. The gonadal glands stood out above the surrounding adipose tissue and adjacent organs and fluoresced a striking shade of intense blue.

Kalotermes minor, pre-alate. The adipose tissue fluoresced a bright blue-white. Here the digestive tract became evident and clearly established its position and structure by fluorescing a dull orange. The digestive system of the other species examined did not offer the degree of fluorescence as noted in *K. minor*. In an attempt to observe the internal organs located close to the exoskelton of a living, ambulant drywood termite, a group of workers were compelled to ingest nothing but black photographic paper. Others fed upon white paper only. When the termites became engorged with black paper, their digestive systems became black and this was clearly detected by the unaided eye. This enabled the organs such as the Malpighian tubules and portions of the tracheal system to stand out in sharp contrast against the blackened background of the digestive system. In the case of the workers that had eaten white paper, only the adipose tissues fluoresced and they provided no background contrasts.

Although experiments were made with chromatograms in an effort to learn something of the fluorescent content of the body, this approach was set aside due to the complexity of attempting to analyze the Rf of the unknowns when making smears of an entire animal. It can be stated, however, that interesting differences in chromatographical separation and content were noted when smears of the three species of termites were subjected to chromatographic analysis.

In order to learn something about the fluorescence of the internal organs of other insects when dissected, a few were selected for trial. The larval form of a dermestid, *Anthrenus verbasci*, showed a strong fluorescence of bluish-white throughout the adipose tissues. Only a slight trace of contrasting colors could be detected from the exposed internal organs.

An American cockroach, *Periplaneta americana*, created a beautiful display of contrasting colors from the various internal organs. The tracheal system showed up a darker blue than the surrounding adipose tissues. The content of the Malpighian tubules gave forth a strong yellow color that enabled one to trace each tubule to its origin. Again the "ring" of the pyloric valve identified

itself by a bright blue. The gastric caeca gave off a greenish-yellow hue.

In order to include an aquatic insect in the investigation of internal fluorescence, the naiad of a dragonfly, *Progomphus borealis,* was selected. Here but little adipose tissue could be detected, which emitted the characteristic blue-white color. Portions of the intestinal tract also gave off a pale shade of blue. Very little could be seen of the remaining organs.

In examining the difference in fluorescence between the alcoholic specimens of scorpions and whip scorpions (order Pedipalpida) it was found that considerable differences in over-all excitation of the two was apparent. In the scorpion, *Hadrurus hirsutus,* the entire external body fluoresced a brilliant bluish-yellow. In an effort to determine if it was the chitin that fluoresced, one of the heavy scutes was dissected and examined under white light. It was found that the chitin was coated with a thin pigment which may be scraped off with the edge of a blade. Once this pigment is removed, the underlying chitin is negative. On opening the body in order to examine the internal organs, it was found that all body content was negative. However, much of this might be accounted for by the fixative used in the preserving media from which it was taken. By contrast the internal organs of the whip scorpion emitted a strong fluorescence while the external chitinous wall was negative. Here again, as found in the insects examined, the thin connecting chitinous membranes over the joints showed a characteristic degree of fluorescence resulting from the tissues within. From the amount of fluorescing pigment found over the entire body of the scorpion, one is led to speculate on the possible significance of this phenomenon. Could it be that the eyes of scorpions are sensitive to a narrow spectral band in the ultraviolet, as reflected from the moon, and are able to locate their kind by the strong fluorescence that is emitted?

It is felt that more is to be learned in the study of internal anatomy of insects and arthropods through fresh dissections made under the influence of ultraviolet illumination. As it is often the content of an organ rather than the organ itself that fluoresces, and as much of this content is lost through chemical changes when specimens are fixed in some solution, the opportunities for anatomical separation become greater when specimens are observed fresh under this type of illumination It is here that the

identity of small organs, fluorescing differently than their surrounding tissues, and the study of minute differences between any two or more substances, are to be observed that would be otherwise difficult to determine under conventional white light.

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ON THE DISTRIBUTION OF BOSTRICHOCLERUS BICORNIS VAN DYKE

The clerid beetle, *Bostrichoclerus bicornis* Van Dyke has been known only from the type specimen collected at Palm Canyon, Angel de la Guardia Island, Gulf of California on May 3, 1921, by J. C. Chamberlin. Therefore it is of interest to report that the second known specimen of the species, constituting the first record of its occurrence in the United States, was found in an unidentified lot of clerid material received from Dr. J. N. Belkin of the University of California at Los Angeles. This specimen, a male, was collected in the Iron Mountains, San Bernardino County, California, by R. Zweifel on April 24, 1950.

This significant collection extends the range of *B. bicornis* approximately 365 miles north of the type locality. It now can be assumed that this insect is distributed over an area much more extensive than formerly believed. Most likely it occurs discontinuously in several of the desert mountain ranges in southeastern California, southwestern Arizona, northwestern Sonora and northern Lower California.—W. F. BARR, *University of Idaho, Moscow.*

Book Review

THE BUTTERFLIES OF THE MALAY PENINSULA by A. Steven Corbet and H. M. Pendlebury, second edition revised by A. Steven Corbet and edited by N. D. Riley, pp. v–xi, 1–537, pls. 1–55, map. 8 vo. £5.5/.7, March 1956. Publ. Oliver and Boyd Ltd., Edinburgh: Tweeddale Court. London: 39A Wellbeck Street, W. 1.

The Butterflies of the Malay Peninsula first appeared in 1934. It was published in Kuala Lumpur by Kyle, Palmer and Co. Ltd. This book was evidently directed primarily to an audience of beginning hobbyists, with very little offered for the attention of advanced students of Lepidoptera or the professional entomologist, and the book has not been particularly well known or widely used. It treated only the commoner representatives of the 801 species of butterflies known from the region at that time. Since then nearly 100 additional species have been found to occur in the area concerned.

The revised edition of the original work finally appeared on March 7, 1956, due largely to the efforts of Irene Corbet, and to N. D. Riley, who edited the new edition after the death of the last surviving author (Corbet) in 1948 as the work was going to press. This new edition is fashioned from the same pattern that served for the first work, but there the resemblance ends. The new edition is virtually an entirely new work, rather than a simple correction and improvement, or revision, of the earlier one. The original 252 pages (plus preface and indices) have been expanded to 496 text pages, with 40 index and 11 preface pages. None of the 16 plates used in the first edition have been retained.

The book is made up of three parts, only the first of which is divided into distinct chapters. Part I consists of ten introductory chapters treating general topics relating to the butterffies of Malaya. Chapter One deals with the adult butterfly where classification to the ordinal level, and external anatomy, are discussed. In the discussion of external anatomy it is refreshing to find a portion devoted to both male and female genitalia. The second chapter considers natural controls and the early stages where larval chaetotaxy is stressed. It is important for beginners to be introduced to the International Commission on Zoological Nomenclature, and this is considered in Chapter Three, "Nomenclature and Classification." The following chapter is devoted to geographical distribution and is an excellent and important section of the book. It has been greatly expanded and revised compared to the presentation in the first edition and provides the reader with an intriguing ecological picture of the Malay Peninsula. The Malay Peninsula Map used in the earlier edition provided a rather more effective idea of relief features within the region, but the new map provides a far superior record of stream drainages. It indicates mountainous features with a 2500-foot interval, but this does not seem to be a serious shortcoming since "the butterfly fauna is more or less homogeneous from the lowlands up to about 2500 feet in primary forest," (p. 34). One of the useful additions to this section is a rainfall chart for eight widely separated Malay localities with the presumably average rainfall presented for each month. The range in annual rainfall for these eight stations runs from 90 inches to 244 inches.

Chapter Five, "Wing Patterns," is introduced with a brief discussion of wing pigments. A rather cumbersome and detailed section on variation and

heredity, which appeared in the old edition, has been completely redone and is presented in a much shorter and simpler manner under "Mendelism." This is followed by an interesting discussion of mimicry, in which the authors properly caution that, "in a subject such as this, there is a temptation to see mimicry where it does not exist" (p. 48). A list of "some of the more noteworthy mimetic associations found in the Malay Peninsula" (p. 49) is given, followed by special statements regarding certain of the cases listed. One of these comments, presumably cautionary, calls attention to the fact that the involved species seldom fly at the same altitudes. If the authors were doubtful about the association, one wonders why it was included in the list. If they entertained no doubts about the association of the species, as might be indicated in a preceding statement (p. 49), "rarely in Malaya do mimetic species fly in precisely the same localities as their models," then one is entitled to ask if the authors applied all of the caution they might have in their discussion of mimicry.

"Duplex Species and Origin of Species" is the subject of Chapter Six. The authors consider that species arise through reproductive isolation between subspecies. The term "duplex species" is not clearly defined, but it seems to represent the "expèces jumelles" of Cuènot or the "sibling species" of Mayer, usually coupled with a superspecies or artenkreis concept. This section dealing with duplex species is extensive and contains many interesting examples.

The next chapter deals with quantative analysis. It is quite short and is concerned primarily with problems of estimating population size. The discussion might have been more profitably devoted to problems encountered in obtaining random samples, virtues and liabilities of the use of statistical methods, analysis of population differences, means of presenting quantitative data visually, etc.

The last three chapters of Part I deal with the history of Malay butterfly collecting, techniques of collecting butterflies in tropical regions, and the preparation and preservation of material. The latter chapter is the only one in the book which remains virtually as it was in the first work. The chapter preceding this, however, is also scarcely altered, except for considerable expansion of the very informative section on fruit baiting.

Part II, the main body of the text, treats systematically all the known species of the butterflies of the Malay peninsula. While a few keys were offered in the first edition of this work, the present volume makes it possible to identify all of the species recorded for Malaya, by use of the very numerous keys. There are many line drawings, mostly of venation, but also of other important structures such as palpi, legs, antennae, and androconal scales and other secondary sex characteristics. Distribution maps and generalized drawings of early stages are occasionally presented. The discussion at the family level is usually long, involving interesting remarks about general behavior, distribution and early stages, in addition to a structural diagnosis which, although usually presented in a mixture of telephonic and telegraphic styles, is not at all disturbing to read.

Keys to generic groups or to genera are then given. The discussion at the group or generic level is usually very brief and involves only diagnosis and distribution. If necessary, a key to species (or genera, as the case may

be) follows. The specific discussion, generally very brief, concerns only the better-known or otherwise remarkable representatives.

The keys are perhaps the main feature of this part of the book. The couplets are, as a rule, clearly stated without ambiguities; however, a reader will occasionally be obliged to decide whether a segment of an appendage is "long and thin," or "comparatively short" (p. 398). A choice between "slender" and "stout" is frequently required. These choices could be better facilitated, perhaps, if the attributes were described in terms of a length-to-width ratio, as is usually done elsewhere in the keys throughout the book. In certain couplets a number of exceptions are noted by name, but no provision is made to allow these exceptions to be keyed, either by giving "or if" alternative characters in the same part of the couplet, or by permitting these exception to be sorted out elsewhere in the key. An example of this is illustrated by the following dichotomy on p. 88: "2(17) Hindwing precostal vein present (but absent in the Pierid subfamily Coliadenae). Forewing with all veins present (except in genera of Pieridae other than *Valeira* and in the Amathusiid genus *Enispe*)." "17 Hindwing precostal vein absent. Forewing vein 8 absent (except in *Deramas* and *Liphyra*, and in ♂ *Iraota, Amblypodia, Pratapa vidura,* sometimes in ♀ also, and *Jacoona* (3 species) (fig. 103). Foretarsi abbreviated in ♂ and usually with one or both claws absent; perfect and with both claws present in ♀ (fig. 122)."

Of the 55 plates, 20 are devoted to male and female genitalia. All the genitalic figures are camera lucida tracings. The figures of these seem to be quite adequate, with the possible exception of those of the few female structures. There is some doubt that these latter figures will be of much value, even at the generic level, since the diagnostic characters are not known for many groups; and it is, therefore, unlikely that these have been effectively illustrated. The 342 genitalic figures have been selected to show diversity in form, and to illustrate all species only in certain genera where identification depends solely upon these organs. The remaining plates are photographic reproductions of adult butterflies, eight of which are in color. Of these latter, plate 27 is out of register and hence blurred. This condition is also evident in plates 23, 24, and 28, but the result is not so serious. The lack of uniformity of print size and style for the photographic plate legends is also disturbing. Plates 22–30 have a facing legend on the blank back of the preceding plate. Plates 31–55 occupy both sides of the pages, so the legend is placed at the bottom of the page. In these cases the legend is, variously, single column with large print, double column with small print, or running lines with small print. This is evidently the result of a compromise for space, but it seems that the problem might have been more pleasingly resolved. Only one error of plate reference in the text was encountered: *Halpe zema ormenes* (Plötz) is figured on plate 46, not 47 as stated on p. 387.

Part III contains material supplementary to the main body of the text. The first section of this part is an extensive synonymic list of the Malayan butterflies, each entry accompanied by data on geographical and ecological distribution. Also included, for many of the species, are references to individual illustrations in Distant's *Rhopalocera Malayana,* and for some, references to unusual records or other explanatory notes which appear at

the the end of the formal list. Another section of this portion of the book provides a generic list of larval food plants known for Malayan species of butterflies.

The bibliography could have been entitled "Literature Cited," since it is not intended to represent a full treatment of the literature. It includes only those works of which specific mention is made in the parenthetical references to "Basic Literature" at the end of many text treatments. It is, nonetheless, somewhat surprising to find no reference to the first edition of this work in the new volume, except for inferences derived from several indications that the present work is a revised edition of an earlier work of some sort. While perhaps the authors did not consider their first effort basic to the present edition, it might at least have been given complete recognition in a footnote somewhere.

The appendix following the Bibliography consists of the expected additions to portions of the text, as well as two revised keys prepared by J. N. Eliot, and a list of the Malayan butterfly names which have been placed on the Official Lists of Names in Zoology together with the relevant opinion. Three indices—a general index, an index of scientific names (of the butterflies only), and an index of vernacular names—constitute the final portion of the book.

The primary function of the book is to provide means for identification of any butterfly from Malaya. A supplementary and perhaps no less important function is to help provide an understanding of the composition of the Malayan fauna as a segment of the Indo-Australian biotic region in terms of its relationship to the geology and ecology of the area. The work is directed to a very wide audience. It is at once both popular and specialized in scope. Specialists in Lepidoptera and workers in other groups of insects will find the section on geographical distribution and the keys and genitalia drawings very useful. The two half-tone plates of certain Linnean and Fabrician Oriental butterfly types might be of some limited use to this audience. The beginner will find a number of subjects treated in a concise manner which are not found in other butterfly books, and his interest will be guided along constructive lines of endeavor. The book is modern in its approach and its nomenclature, and the organization of the subjects is excellent. In the above respects, it will be found to be one of the finest butterfly books currently available. It should receive wide use and prove to be a real contribution to the vast accumulation of literature on Lepidoptera.—C. Don MacNeill, *University of California, Berkeley.*

REMARKS ABOUT CICINDELIDS, WITH DESCRIPTIONS OF TWO NEW SUBSPECIES

(Coleoptera)

C. M. C. Brouerius van Nidek

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The following remarks are based on a study of cicindelids sent by the California Academy of Sciences, San Francisco.

PROTHYMA TRIUMPHALIS W. Horn

This *Therates*-like species, known from Tonkin and Macao, was represented by one example from Yim Na San, East Kwantung, South China.

CICINDELA TRIGUTTATA Herbst

Three examples of this common species, from Hainan Island.

Cicindela psilica luchuensis van Nidek, new subspecies

In *C. psilica psilica* Bates the median white spot is separated from the margin by a bright blue colored mariginal side line. In the new subspecies this blue side line is missing and the median spot reaches the epipleurae; the median white spot is longer and narrower than in the typical form. The two apical spots are connected, forming a lunule. The color of the elytra is darker, with a coppery shine.

Holotype and allotype from ISHIGAKI, YAEYAMA JIMA, LUCHU ISLANDS JAPAN, May, 1910 collected by V. Kuhner; types deposited in the California Academy of Sciences. Paratypes: 6 (C.A.S.) topotypical; 6 (Wiener Naturhist. Museum) with locality Vaeyama Loochoo, v-1909, leg. Sauter. Both Jaerama and Vaeyama are variant spellings of Yaeyama, in the Ryukyu Islands. Paratypes in the collections of the California Academy of Sciences, Wiener Naturhist. Museum, Prof. Dr. Karl Mandl, and van Nidek.

CICINDELA ELISAE REDUCTE-LINEATA W. Horn

Two specimens from Formosa. One, from Rokki, corresponds fully with W. Horn's description. The other, from Heito, has the signature not at all reduced and is much greener.

CICINDELA SUMATRENSIS Herbst

Two specimens from Japan. It is remarkable that the examples from Japan and China I have seen, are much larger than those from Java and Sumatra. The average length of these two Japanese specimens is 8.5 mm., of three China specimens 8 mm., and of the specimens I collected on Java, 6 mm.

CICINDELA BREVIPILOSA KLAPPERICHI Mandl

This subspecies was described as from Fukien. Prof. Mandl already mentioned in his description (Mitteilungen der Münchner Entomologischen Gesellschaft, 32(1):87–89. 1952) that specimens from Che-Chiang would also probably belong to his new subspecies.

Among the determinanda were six specimens from Che-Chiang; Prof. Mandl was so kind as to confirm my identification.

Cicindela discreta celebiana van Nidek, new subspecies

Differs from the nominate form by the signature of the elytra. This new subspecies has two humeral spots instead of a humeral lunule, and lacks the apical marginal line.

Holotype from the Island of CELEBES, INDONESIA; in my collection. Paratypes in the collections of the California Academy of Sciences, Zool. Museum Hamburg, and in mine.

This subspecies inhabits Celebes and the small islands around its coasts. According to information from London and Paris, these markings are quite constant in Celebes specimens, and very rare in examples from other localities. As I have not seen the latter specimens myself, it is quite possible that these exceptions refer to beetles from the small islands near Celebes.

CICINDELA KALEEA ANGULIMACULATA Mandl

C. kaleea kaleea Bates is a common Chinese species. The shipment contained a lot of them, including the subspecies *cathaica* Bates and the nice *humerula* W. Horn from Okinawa. Moreover, there were four specimens from Formosa which I believed to be a new subspecies. In correspondence with Prof. Mandl about the species *kaleea* and its subspecies, he wrote me that he had just finished his description of a new subspecies named *anguli-maculata*, from Formosa. After having sent him the specimens, he confirmed them to be identical with his new subpecies and labelled them as paratypes. These are in the collection of the California Academy of Sciences and in mine.

CICINDELA MINUTA Olivier

Six specimens from Nan-ning, Kowang-Si, China. This is a new locality for this species. In contradistinction to *C. sumatrensis* Herbst, these examples are not larger than the more southward specimens. Differences in this species are rare.

CINCIDELA MASTERSI Castelnau

Two specimens labelled Fiji. This species inhabits Australia and New Zealand. In Walther Horn's "check list" it is not mentioned for Oceania. I am inclined to doubt the accuracy of the locality labels on these specimens.

DISTRIBUTIONAL RECORDS FOR SOME SPECIES OF PLEOCOMA

(Coleoptera, Scarabaeidae)

E. GORTON LINSLEY
University of California, Berkeley

The distributional data reported below represent presumably significant extensions of the known ranges of several species of *Pleocoma*. Most of the records are from specimens represented in the collection of the California Insect Survey, University of California, Berkeley.

PLEOCOMA AUSTRALIS Fall

This species has been reported previously from the San Gabriel Mountains in Los Angeles and San Bernardino Counties, Calif. (Fall, 1911; Davis, 1935; Linsley, 1941), the San Jacinto Mountains, Riverside County (Linsley, 1941, 1945), and from Hot Springs Mountain, in northern San Diego County (Moore, 1937; Linsley, 1941). New records from the Laguna Mountains now extend the known range to southern San Diego County. These are as follows: Laguna Mountains, elevation 5400 ft., August 28, 1945, one male excavated from the ground at a depth of one ft. (W. H. Doetschman); and Laguna Mountains, 6.5 mi. N.E. of Laguna Junction, October 12, 1945, two males, one female, uncovered by road construction (W. H. Doetschman).

PLEOCOMA EDWARDSI Le Conte

This species has been recorded previously from Yuba and Nevada Counties. The following are new county records and northern extensions of the known range: De Sabla, Butte Co., Calif., November 9–11, 1954, 11 females and 67 males (D. Black and F. R. Platt); and 2 mi. W. of Forbestown, Butte County, November 11, 1954, 1 male (F. R. Platt). Mr. Platt is of the opinion that the larvae of this species normally feed on the roots of Douglas fir, *Pseudotsuga taxifolia* and that at the De Sabla locality they were also attacking the roots of apple trees in an abandoned orchard.

PLEOCOMA FIMBRIATA Le Conte

This species has been recorded previously from Nevada, Placer, and El Dorado Counties (Linsley, 1945). Northern extensions of the known range are: Kelley Ridge, 6 mi. E. of Oroville, Butte County, October 23–28, 1951, numerous males taken from an irrigation flume (F. R. Platt); foothills N.E. of Oroville, Butte

County, November 16, 1955, 7 males. (R. O. Schuster); and 1 mi. S. of Lake Wyandotte, Butte County, November 15, 1955, two males, one female (R. O. Schuster). Southern extensions: Sonora, Tuolumne County, elev. 1850 ft., October 10, 1945, one male, at light (E. G. Linsley, J. W. MacSwain, and Ray F. Smith); and Phoenix Lake, near Sonora, Tuolumne County, October 11, 1945, one male, trapped in ditch water (E. G. Linsley, J. W. MacSwain and Ray F. Smith).

Mr. Platt states that in Butte County this species occurs in the foothills at low elevations, *P. edwardsi* in forested areas at higher elevations.

PLEOCOMA HIRTICOLLIS VANDYKEI Linsley

A specimen submitted for study by A. T. McClay, provides a significant extension of the range of this subspecies. The example, a male, was captured along Cache Creek, near Rumsey, in northern Yolo County, California, on November 27, 1955, by E. A. Kurtz. This form has been recorded previously from Sonoma County (without definite locality) and the Oakland Hills, Alameda County (Linsley, 1938); Eldridge, Sonoma County (Linsley, 1941); Patterson Pass, in eastern Alameda County (Linsley, 1945; Smith and Potts, 1945; Ritcher, 1947); and Lafayette, Contra Costa County (Linsley, 1945).

P. hirticollis vandykei appears to be limited to the central Coast Ranges, the nominate subspecies to the Sierra Nevada foothills (Yuba and Nevada Counties). Smith and Potts (1945) have recorded the association of *vandykei* with open, hilly grassland.

PLEOCOMA HOPPINGI Fall

Through the kindness of W. W. Middlekauff I have examined fragments of males of this species taken from three coyote stomachs collected March 10, 1955, at Dry Meadow, Kern County, California (NE ¼ corner, Sec. 22, T 22S, R 32 E), by Howard R. Leach, Assistant Game Biologist, Food Habits Laboratory, California Department of Fish and Game. When the stomach contents were measured by water displacement, one animal (coll. No. 10,561) contained 22.8 cc of *Pleocoma* fragments, another (No. 10,564), 25.0 cc., and the third (No. 10,565) a trace. *P. hoppingi* has been recorded previously from feces, presumed to be those of coyotes, found in the vicinity of Miami Ranger Station, Mariposa County, California (Linsley, 1942:165, plate 30).

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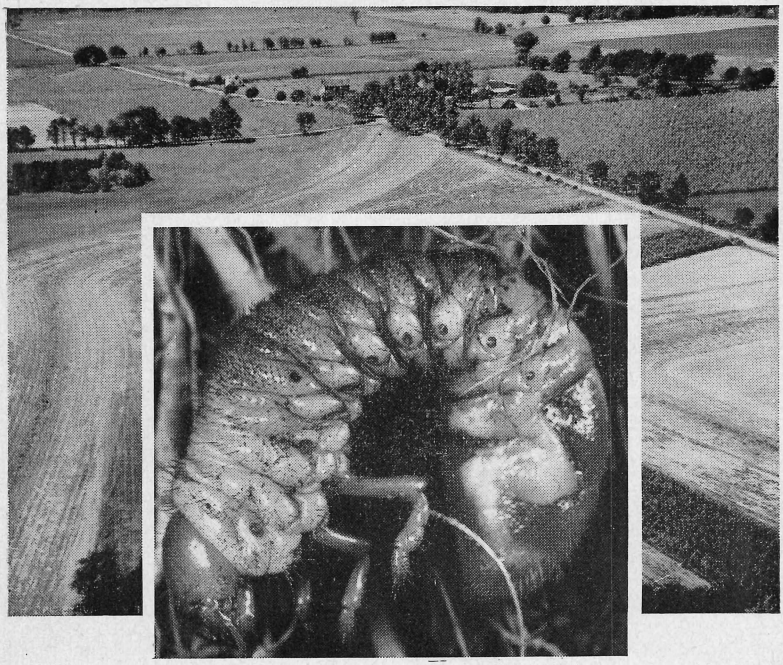

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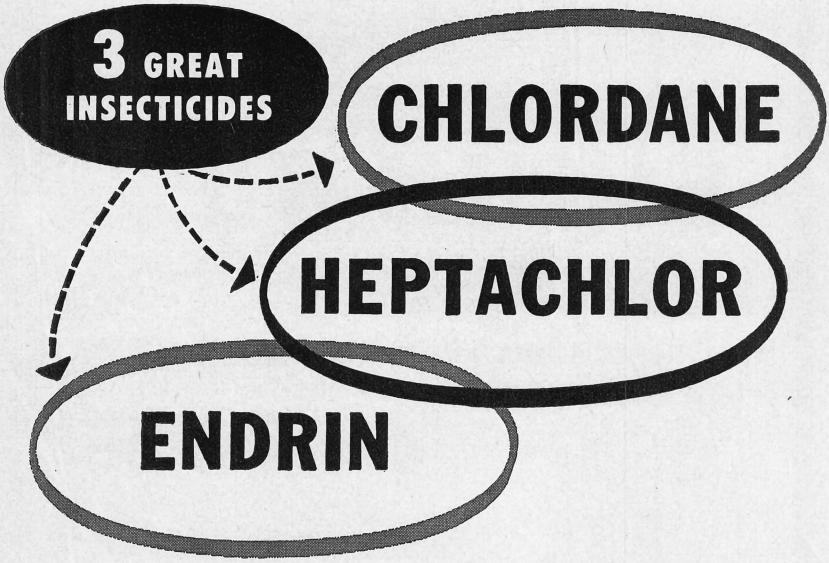

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CHLORDANE: Ants, Armyworms, Blister Beetles, Boxelder Bug, Brown Dog Tick, Cabbage Maggot, Carpet Beetles, Cattle Lice, Chiggers, Cockroaches, Crickets, Cutworms, Darkling Beetles, Dog Mange, Earwigs, Fleas, Flies, Grasshoppers, Household Spiders, Japanese Beetle Larvae, Lawn Moths, Lygus Bugs, Mole Crickets, Mosquitoes, Onion Maggot, Onion Thrips, Plum Curculio, Sarcoptic Mange, Seed Corn Maggot, Sheep Ked, Silverfish, Sod Webworms, Southern Corn Rootworm, Strawberry Crown Borer, Strawberry Root Weevils, Sweet Clover Weevil, Tarnished Plant Bug, Termites, Ticks, Wasps, White Grubs, Wireworms...and many others.

HEPTACHLOR: Alfalfa Snout Beetle, Alfalfa Weevil, Ants, Argentine Ant, Armyworms, Asiatic Garden Beetle Larvae, Black Vine Weevil, Root Maggots, Clover Root Borer, Colorado Potato Beetle, Corn Rootworms, Cotton Boll Weevil, Cotton Fleahopper, Cotton Thrips, Crickets, Cutworms, Egyptian Alfalfa Weevil, European Chafer, Eye Gnats, False Wireworms, Flea Beetles, Garden Webworm, Grasshoppers, Japanese Beetle, Leaf Miners, Lygus Bugs, Mormon Cricket, Mosquitoes, Narcissus Bulb Fly, Onion Maggot, Onion Thrips, Rapid Plant Bug, Rice Leaf Miner, Salt Marsh Sand Fly, Seed Corn Maggot, Spittlebug, Strawberry Root Weevils, Strawberry Rootworms, Sugar Beet Root Maggot, Sweet Clover Weevil, Tarnished Plant Bug, Tuber Flea Beetle, Western Harvester Ant, White Fringed Beetles, White Grubs (June Beetles), Wireworms ...and many others.

ENDRIN: Budworms, Cabbage Worms, Cotton Boll Weevil, Cotton Bollworm, Cotton Fleahopper, Fall Armyworm, Grasshoppers, Hornworms, Leafworms, Rapid Plant Bug, Spiny Bollworm, Sugar Beet Webworm, Tarnished Plant Bug, Thrips.

WRITE FOR FULL PARTICULARS

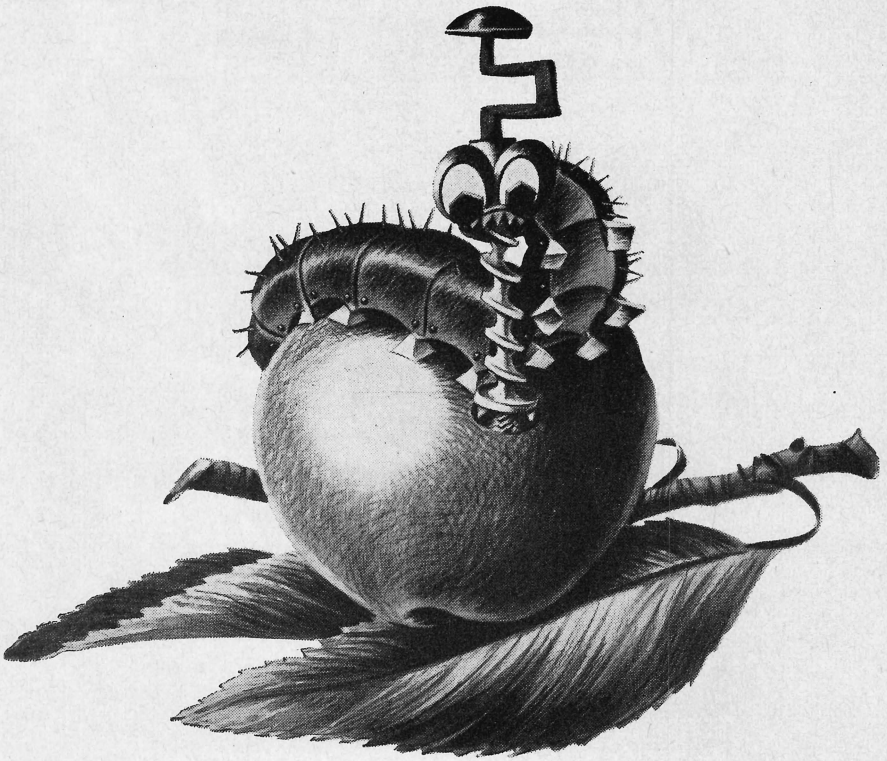
VELSICOL CHEMICAL CORPORATION

VELSICOL

General Offices and Laboratories
330 East Grand Avenue, Chicago 11, Illinois

Foreign Division
350 Fifth Avenue, New York 1, N. Y.

REPRESENTATIVES IN PRINCIPAL CITIES



Their weapons never change ... but ours do

Insects drill, chew and shred crops according to the tools they carry. Their techniques never change. The ways which farmers fight these insects, however, are constantly improving . . . largely through chemistry. Today, better weed killers, insecticides and fungicides help reduce crop losses. Tomorrow, chemical research promises us even more efficient control of crop destroyers.

Diseases, weeds and insects lurk on every farm. Du Pont scientists are constantly looking for better ways to stop them. Control of weeds with substituted urea herbicides, with their practically season-long weed control, will be a boon to farmers growing asparagus, sugar cane and certain other crops. One of the very few insecticides approved for use on dairy cows is methoxychlor, a Du Pont discovery. Control of the major diseases of tomatoes is now possible with the newest addition to the list of Du Pont carbamate fungicides . . . Manzate®.

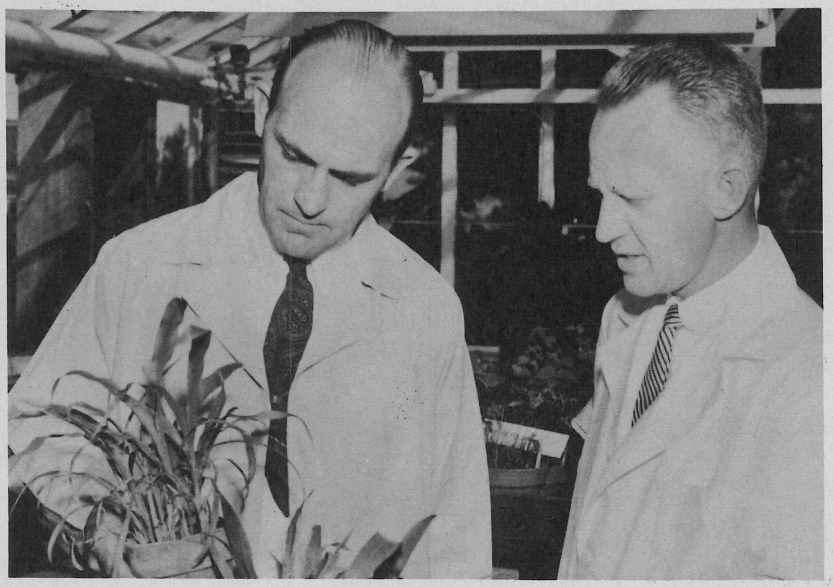
The goal of Du Pont research is chemicals such as these . . . products to increase your opportunities for growth and success in agriculture.

DU PONT
REG U.S. PAT. OFF.

E. I. du Pont de Nemours & Co. (Inc.)
Grasselli Chemicals Department, Wilmington, Delaware

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Here's the Story of Expansion In ORTHO Applied Research



Long recognized a leader in fundamental agricultural pesticide research, ORTHO is intensifying its emphasis on applied biological research.

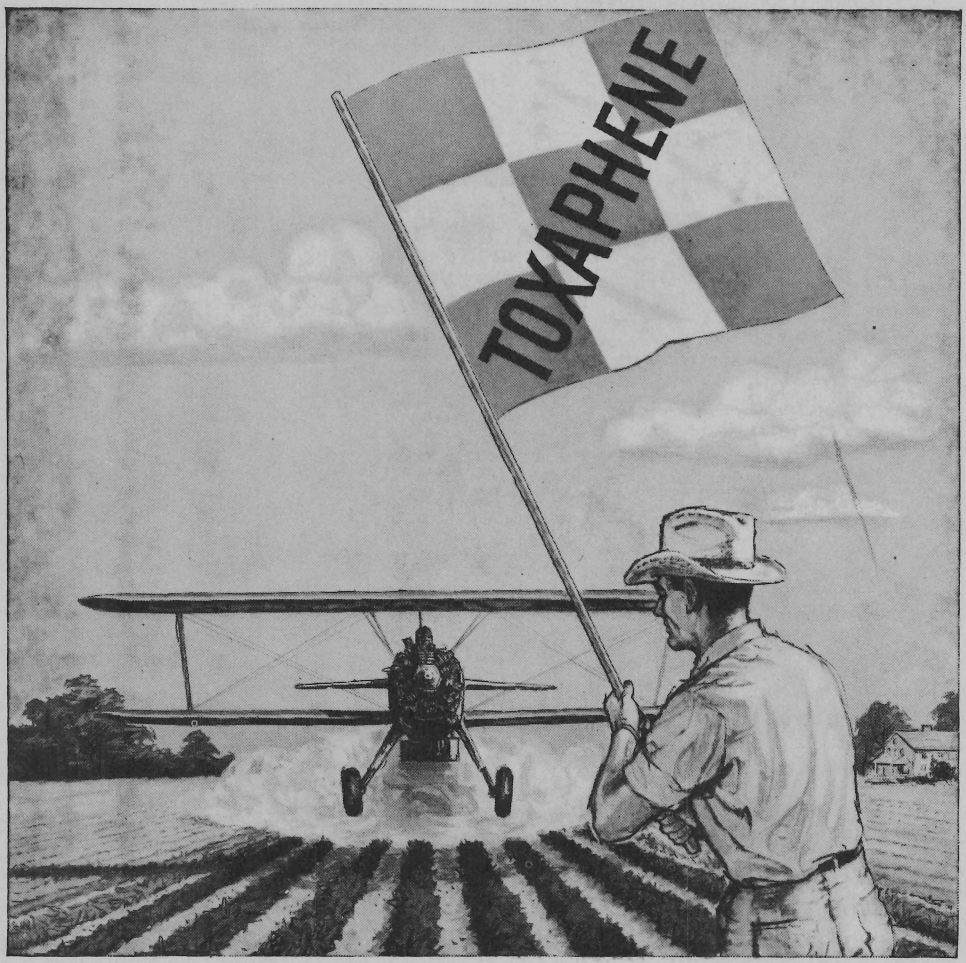
ORTHO now has a total of 13,200 square feet of modern biology laboratories, 10,800 square feet of experimental planting area under glass, and 28 acres of experimental plots.

Intensive greenhouse field testing of new fungicides, bactericides, and nematocides—developed by ORTHO fundamental research—is now in progress on many economic crops and ornamentals.

You are cordially invited to use proven ORTHO pesticides in your work—as well as newest formulations, tested by ORTHO biological research laboratories, as they become available.

For technical information on newest ORTHO formulations, write Dr. R. K. Thompson, Field Research Supervisor, West; California Spray-Chemical Corp., Richmond 4, California.

ORTHO



LEADING GROWERS OF MANY CROPS DEPEND ON TOXAPHENE FOR SEASON-LONG INSECT CONTROL. FOR EXAMPLE, TOXAPHENE IS OFFICIALLY RECOMMENDED FOR CONTROL OF MORE COTTON INSECTS THAN ANY OTHER INSECTICIDE.

970 Market Street, Wilmington 99, Del.

Agricultural Chemicals Division, Naval Stores Department

HERCULES POWDER COMPANY

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